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IMPERIAL AGRICULTURAL RESEARCH CONFERENCE, 1927.

Facilities for Advanced Study and Research

in

AGRICULTURAL SCIENCE

and

COGNATE PURE SCIENCES

in the

United Kingdom.

LONDON:
PRINTED UNDER THE AUTHORITY OF HIS MAJESTY'S STATIONERY OFFICE
And to be obtained at the Office of the
MINISTRY OF AGRICULTURE AND FISHERIES,
10, WHITEHALL PLACE, LONDON, S.W. 1.

1929.

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PREFACE.

The Imperial Agricultural Research Conference, 1927, made the recommendation that, with a view to arrangements for study leave for agricultural research workers in the Empire, a careful statement should be prepared and issued of facilities for study and research in agricultural science and the cognate pure sciences.

The present volume relating to the United Kingdom has been prepared as a result of this recommendation. It contains particulars of—

I. Institutions carrying out agricultural research, with principal members of the staff, short appreciation of fields of research, and account of facilities for research.

II. University professors in pure sciences cognate to agriculture, arranged under sciences.

III. Professors, readers and lecturers in agriculture and cognate pure sciences at universities at which agricultural research and teaching are carried out.

It will usually be necessary for agricultural research workers on study leave at any university to become members of that university; attention is called to the desirability of early arrangements for this purpose with university authorities. Particulars should also be obtained from those authorities of the conditions on which degrees or diplomas are awarded for post-graduate study.

In the preparation of this volume the advice and assistance of the Chairman of the Committee of the Conference on Recruitment, Training and Interchange of Workers (Mr. F. L. Engledow) have been freely given.

Suggestions for improving the usefulness of this volume without unduly expanding its bulk will be welcomed.

Ministry of Agriculture and Fisheries,
10, Whitehall Place,
London, S.W. 1.

February, 1929.

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IMPERIAL AGRICULTURAL RESEARCH CONFERENCE, 1927.

Recommendations on Study Leave and Interchange of Workers.

VI. STUDY LEAVE.

87. Study leave offers so many advantages that it should, as soon as possible, be made a feature of every agricultural service. Staff increases may be necessary to that end. Travel is, of itself, stimulating. To an officer working in comparative isolation a period of work with an appropriate specialist re-equips him. Reading, for which the duties of most officers in most countries leave inadequate time, may be pursued with the leisure and scientific amenities upon which profitable reading depends.

88. The form of study leave must necessarily vary widely. If spent in a laboratory or institution it should be of such length as to allow at least two months' actual work.

89. Tours of a number of institutions, embracing a short stay at each, are likely to be of advantage only to experienced officers.

90. Great care should be exercised in planning study leave. Mere attendance at an institution " to see what is going on " is to be deprecated on many grounds. There should always be a well-thought-out course of study or investigation. The institution should be carefully chosen upon competent advice, and arrangements with the officers of the institution should be made well in advance. In particular the time of the leave period should be arranged to avoid inconvenience to the institution and to ensure the fullest amenities to the visitor.

91. The best basis for study leave arraugements is the Imperial basis, the Dependencies acting as a unit of organization. The essentials for an Imperial basis are two : knowledge of facilities throughout the Empire must be made available ; a machinery is required for affording detailed guidance and arranging accommodation. Facilities would best be described for each separate unit of the Empire. Every Dominion, including the Home Country, and also the Dependencies as a unit, should prepare and issue a careful statement on " Facilities for Study and Research." This should include not only facilities for agricultural science, but also for the cognate pure sciences. Names of institutions, and of workers, with appreciations of fields of study, should be included. The best form of this publication would probably not be the same for every part of the Empire, but all possible uniformity should be ensured.

92. Detailed guidance and arrangements for accommodation are the second requirement. It appears probable that the Imperial bureaux and correspondence centres could successfully undertake this work. One Imperial " clearing house " for the purpose would result in perfunctory and cumbersome discharge. The final arrangement would have to be effected between worker and worker. The bureaux and centres would serve to put worker and worker into friendly correspondence, and no more than this is needed.

93. One special form of study leave deserves careful consideration. A Government might, with great profit, invite a distinguished worker from another country to visit a number of its centres of research. Here, in an

informal friendly way, he could meet men engaged in his own department of study. To some of them he could give direct assistance and information and possibly suggest helpful ideas. For an arrangement of this kind no Imperial machinery would be necessary : advice, if needed, could be obtained through the Imperial bureaux and centres.

VII. INTERCHANGE OF WORKERS.

94. That interchange for periods of one to three years might bring handsome advantages is apparent : and the advantages would not be limited to scientific progress alone. But a routine, more or less compulsory, interchange would be extremely undesirable. Beneficial interchanges will suggest themselves. No formal provision is necessary, but financial provision should be made as required. The Imperial basis suggested for study leave would serve here.

95. At present " interchange " in the Empire does not appear to have been developed to the fullest possible advantage. In some of the less wealthy countries the reason for this is definitely the financial one. Some financial difficulty, direct or indirect, affects the possibility of interchange in all countries. It appears reasonable and proper to ask the appropriate authorities to consider favourably this important means of stimulating research.

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I.

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A.—Soils and Crops.

(1) ROTHAMSTED EXPERIMENTAL STATION, HARPENDEN, HERTS.

Railway Station :—Harpenden (L.M.S.) *Telephone* } Harpenden 21.
Telegrams }

Staff.

Director :—Sir E. John Russell, O.B.E., D.Sc., F.R.S.
Assistant Director :—B. A. Keen, D.Sc., F.Inst.P.

Heads of Departments.

Bacteriology	H. G. Thornton, B.A.
Botany	Winifred E. Brenchley, D.Sc., F.L.S.
Chemistry	E. M. Crowther, D.Sc., F.I.C.
Fermentation	E. H. Richards, B.Sc., F.I.C.
Insecticides and Fungicides	F. Tattersfield, D.Sc., F.I.C.
General Microbiology ..	D. W. Cutler, M.A., F.L.S.
Soil Physics	B. A. Keen, D.Sc., F.Inst.P.
Statistical	R. A. Fisher, M.A., Sc.D.
Entomology	A. D. Imms, M.A., D.Sc., F.L.S.
Mycology	W. B. Brierley, D.Sc., F.L.S.

Other Members of Graded Staff.

Assistant Entomologist ..	H. F. Barnes, B.A.
,, *Physicist* ..	G. W. Scott Blair, B.A.
,, ,, ..	G. H. Cashen, M.Sc.
,, *Microbiologist*	Miss L. M. Crump, M.Sc.
,, *Entomologist* ..	
,, *Mycologist* ..	M. D. Glynne, M.Sc.
,, *Bacteriologist* ..	P. H. H. Gray, M.A.
,, *Entomologist* ..	D. M. T. Morland, M.A.
,, *Microbiologist*	H. Sandon, M.A., Ph.D.
,, *Mycologist* ..	J. Henderson Smith, M.B., Ch.B.
,, ,, ..	R. H. Stoughton, B.Sc., A.R.C.S.
,, *Chemist* ..	R. G. Warren, B.Sc.
,, *Statistician* ..	J. Wishart, M.A., D.Sc.
Ecologist	A. R. Clapham, B.A.

Aims of the Station.

The purpose of the Rothamsted Experimental Station is to obtain information on soil conditions and the growth of plants, and to use this knowledge in advancing agricultural science, in improving the standards of farming and in agricultural education. The general method of investigation is to start from the farm and work to the laboratory or *vice versa*.

There are four great divisions in the laboratory—biological, chemical, physical and statistical—which may be regarded as the

pillars on which the whole structure rests. But the method of investigation differs from that of an ordinary scientific laboratory, where the problem is usually narrowed down so closely that only one factor is concerned. On the farm such narrowing is impossible ; many factors may operate and elimination results in conditions so artificial as to render the enquiry meaningless. In place, therefore, of the ordinary single factor method of the scientific laboratory, liberal use is made of statistical methods which allow the investigation of cases where several factors vary simultaneously. In the crop investigations a large number of field observations are made ; these are then treated statistically to ascertain the varying degrees to which they are related to other factors—such as rainfall, temperature, &c.—and to indicate the probable nature of the relationships. Thus the complex problem becomes reduced to a number of simpler ones susceptible of laboratory investigation.

In addition to the classical field experiments laid down by Lawes and Gilbert from 1839 onwards, many other field trials are made on the Rothamsted farm. Some of the more important are repeated elsewhere, in order to assess the influence of different soil and climatic conditions. Some fifty centres throughout the country are used for this purpose, in addition to the Woburn Experimental Farm, where field plots were laid down in 1877 to repeat on light land the permanent experiments instituted earlier at Rothamsted.

The facilities provided by the Station for post-graduate workers, especially those from overseas, and agricultural officers on study leave, have been extensively utilised.

Summary of Work.

For convenience the work in progress is summarised under the following main heads :—(I) Soil problems, (II) Fertiliser investigations, (III) Factors affecting plant yield and quality of produce, (IV) Control of disease, (V) Field experiment procedure. These divisions are not rigidly maintained in the work ; many borderline problems are under co-operative investigation by several laboratories in the institution.

I. *Soil Problems.*

These may be again divided into (*a*) chemical, (*b*) physical, and (*c*) biological.

(*a*) *Chemical.*—Extensive laboratory work is in hand on the humic material of the soil. Its mode of formation and its relation to the nitrogen supply of the soil have a close bearing on practical questions of organic manuring, and on certain aspects of soil fertility.

The relation of the exchangeable bases in the soil to its fertility is also being studied. The classical plots at Rothamsted and Woburn provide unique material for this investigation, as many of the effects of manures (*e.g.* soil acidity) have been accentuated by the long continuance of the treatment.

The serious increase in the area of acid soil in this country has necessitated especial attention to methods of measurement, and to remedial measures ; a beginning has also been made in the analogous problem of alkalinity that faces many irrigated areas in the Empire.

(*b*) *Physical.*—The yield of crops is determined not only by the content of available nutrients but also by the physical condition, or tilth, of the soil. Physical studies of the aggregation of particles into the compound aggregates characteristic of tilth show that both mechanical and colloidal factors are concerned. Special apparatus has been devised for measuring cohesion, plasticity and many of the complex water relationships ; and the work has been extended to direct field studies and comparisons of cultivation processes. As cultivation is still the most costly single item in the farmer's expenditure, attention is being given to methods of improving its efficiency and reducing its cost. Heavy dressings of chalk on strong land not only improve its texture but are found to ensure a lasting reduction in the resistance of the soil to the passage of cultivation implements.

Rotary cultivation has also been investigated as a means of spring cultivation, producing a seed bed in one operation. The results are quite encouraging, as the main difficulty anticipated—an impairment of tilth due to too fine comminution—has only occurred in one year, and then only half-way through the growing season.

In the field experiments much use is made of a recording dynamometer. Fields apparently uniform to visual inspection show surprisingly wide variations in resistance from point to point, but fortunately, these variations do not alter appreciably from year to year. Hence, by a previous survey it is possible to allow for them when comparing the relative efficiencies of different implements.

(*c*) *Biological.*—The study of the activities of the soil population constitutes one of the most important sections of the Rothamsted programme. The population is highly complex : bacteria, protozoa, fungi, algæ, and insects are studied in their relations to one another, to soil fertility and plant growth. Bacteria and protozoa rapidly fluctuate in numbers, certain species of the latter exhibiting a remarkable inverse relationship with the total bacterial numbers. The life cycle and physiology of certain of the more important species of bacteria and protozoa are being worked out with special reference to methods of control of the soil population. For some time past steam and volatile antiseptics have been used for this purpose in glass house practice. The extension of their use was the direct outcome of investigations at Rothamsted ; the technical problems in their application were sufficiently important to necessitate the establishment, in the centre of the industry, of a separate research station, which maintains close co-operation with Rothamsted, where the fundamental problems are still being studied.

A further extension of this microbiological work, done jointly

with the Fermentation Staff, consists in a study of treatment by biological filtration, of sugar beet effluent.

Much of the work on the soil population is directly related to plant growth and fertiliser investigations, and is referred to under those headings.

II. *Fertiliser Investigations.*

These may be broadly grouped into (*a*) artificial manures, (*b*) organic manures.

(*a*) *Artificial Manures.*

Phosphatic manures.—The agricultural properties of the three kinds of basic slag now available (Bessemer, Open Hearth high soluble and Open Hearth low soluble) are being studied and chemical methods are being devised to evaluate them.

The solubility in the old official 2 per cent. citric acid solution is proving to be a useful and easily applied test of value. Other constituents of the slag, however, appear to play a part so that the indications afforded by any one test are not always in accordance with the results of field experiments. Broadly speaking, the variations among slags of solubility below 60 per cent. are generally in accordance with the solubility, while those among slags of 70 per cent. or more solubility usually are not. A new method of examination is being worked out with special reference to the fluorine content.

The uptake of phosphate from the soil and added phosphatic fertilisers by the growing plant is receiving extended study in both field and pot experiments ; mineral phosphates, slags, and superphosphate are being contrasted and compared in this work.

Potassic fertilisers.—The quality of crop produce is improved by potassic fertilisers and attempts are being made to express this in chemical terms. The action between these manures and the soil is under investigation as part of the work on base exchange already mentioned.

Nitrogenous fertilisers.—The number of compounds on the market capable of supplying nitrogen in an available form steadily increases. Their mode of action and factors influencing this are under investigation. Special attention is being given to those nitrogenous fertilisers (*e.g.*, calcium cyanamide) whose action depends on a complex series of decompositions with the soil.

Other elements influencing plant growth.—There is evidence that certain compounds, such as silicates, can either augment the effect of artificial manures, or, in part, replace them. Other substances, such as boron and manganese, are essential to the proper development of certain plants ; these phenomena are being critically studied and the possibility of applications to practice is being watched.

(*b*) *Organic Manures.*

The quantity of farmyard and stable manure is less than could usefully be absorbed by the farming industry. Two methods of supplying organic material to the soil are being investigated.

Green manuring.—This well established practice is being studied with a view to its extension. Field trials laid out with the co-operation of the Royal Agricultural Society of England in different parts of the country gave information about the practical difficulties which are now being further studied. The laboratory work forms one section of the humic material investigations already mentioned.

Synthetic Farmyard Manure.—A laboratory investigation of certain organisms capable of attacking cellulosic material led to the development of a practical method of rotting down waste vegetable matter. This process has been utilised successfully, not only in this country but in many parts of the Empire, and its commercial development has been transferred to a non-profit making syndicate (Agricultural Developments Company).* In the Rothamsted laboratories, investigations are in progress on the more resistant materials, and especial attention is being paid to the part played by fungi as distinct from bacteria.

III. *Factors Affecting Crop Yields and Quality of Produce.*

Although yield is, and must be, the main consideration for most farm crops, questions of quality are becoming increasingly important ; in many cases, *e.g.* potatoes and malting barley, expert valuers have evolved their own methods for assessing quality and fix the price they are prepared to pay on that basis. Samples of produce, graded and valued in this way by a committee of valuers, are being examined in the laboratory in order to see what relations exist between chemical and other properties and the valuation. At the same time the whole growth period of the crops is being followed by frequent physiological measurements, to ascertain the most significant periods and environmental conditions that determine the final yield and quality. These general principles of attack apply to the separate investigations detailed below :—

Malting Barley.—In conjunction with the Institute of Brewing, samples of barley grown under known manurial conditions in the chief barley growing districts of the country, and of malts made therefrom are being examined. A critical study is also being made of the relation of the nitrogen compounds of barley to its malting value. Further information on the development of the crop is being sought by pot and water culture experiments in which phosphorus, potassium and nitrogenous compounds are supplied for limited periods only instead of throughout growth.

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* N. B.—This, the original title of the Company, was changed to Adco, Ltd., by permission of the Board of Trade, in 1925.

Sugar Beet ; Mangolds.—The influence of manuring, potassic, phosphatic and nitrogenous, and of spacing and time of sowing, on yield and sugar content of sugar beet is being studied both at Rothamsted and Woburn. Chemical examination is being made of the mangolds from the permanent plots on Barnfield, where the long continued manurial treatments have accentuated differences due to nutritional factors.

Potatoes.—Considerable attention is devoted to the potato crop owing to its importance in British agriculture. The investigations include the effect of fertilisers on yield and quality, the relations between quantity of fertiliser and amount of growth and the effect of various ratios of plant nutrients. Studies are also made of the effect of the chlorides on yield and quality.

The chemical investigations include determinations of starch and other constituents, but none of these is simply related to cooking quality or to nutrient supply ; there is a considerable seasonal effect which is not yet understood.

The Influence of Season on the Yield and Quality of Produce.—Agriculturists are familiar with the profound effect of season in modifying the effects of fertilisers and soil treatments. This effect is under investigation.

The method adopted is to obtain field data of known accuracy and then to correlate these with the meteorological observations. This has necessitated complete revision of the methods of conducting field experiments, the older methods being unsuitable for statistical investigation.

The Leguminous Crops.—These stand in rather a different category from the remaining crops of the farm by reason of their association with certain of the soil micro-organisms.

Lucerne.—A study of the life history of the nodule organism associated with this legume has shown that the period during which it is motile, or capable of independent movement in soil, can be increased by additions of phosphate. This knowledge has been applied in an improved method of inoculating lucerne seed. In co-operation with the Royal Agricultural Society of England field trials are being made at some fifty centres in Great Britain, to ascertain whether inoculation and suitable cultivation methods will enable the crop to be successfully grown outside the present limited area—the East and South-East of England. Marked success has attended this experiment ; inoculation has not only produced good crops where none could be grown before, but in cases where the crop was grown, it has frequently resulted in increased yields, increased percentage of nitrogen in the tops, or both.

Physiology of Leguminous Crops.—In water culture experiments the growth of many leguminous plants is often unsatisfactory, although adequate supplies of the conventional nutrients are present,

and the presence of boron in minute quantity has been shown to be essential for satisfactory growth.

In these cases, nodule development is also influenced by boron, as in its absence abnormal and useless nodules are produced and the helpful symbiotic association between the plant and the nodule organism (*Bacillus radicicola*) is replaced by a parasitic relationship.

IV. *Control of Disease.*

It is difficult to obtain any reliable estimate of the annual loss to British farmers directly due to plant diseases, but the best judges consider that it is at least 10 per cent. of the total value of the crop. The causes of many diseases are still obscure, and much fundamental work remains to be done before preventive or remedial measures can be evolved. This is especially true of the group known as virus diseases. Meanwhile many of the problems are urgent and empirical methods of control must be tried, or alternatively a search for immune varieties of plants must be made.

Diseases may be caused by (*a*) viruses, (*b*) fungi, (*c*) bacteria and by (*d*) insects.

(*a*) *Virus Diseases.*—The nature of viruses is still unknown, and although minute bodies have been found apparently related to the diseased condition, it has not been possible to cultivate any organism from such plants. Viruses may be obtained in extracted plant juice, and considerable study has been given to their purification and physical relationships. Viruses may occur singly or in combination, and it has been possible to analyse diseases caused by mixtures and to resynthesise them. The work is being carried out principally on tomatoes and potatoes, and the relation of certain virus diseases of these plants to conditions of temperature, etc., are being studied.

(*b*) *Fungus Diseases.*—Most diseases are caused by fungi, and it has been found that many species of fungi consist of numerous strains each of which has its own structural and physiological characters. The changeability of these strains and the relation of this to disease causation in economic plants is being studied, particularly in relation to *Botrytis cinerea*, the cause of " grey mould."

The physiology and genetics of the smut fungi have been studied with special reference to diseases of cereal crops.

Wart Disease of potatoes has received much attention, and it has been found that other plants besides the potato may be attacked, and also that the immune varieties of the latter may show slight infection in which the fungus does not seem to develop beyond the stage of the liberation of summer sporangia. A rapid and reliable method of testing immunity or susceptibility has been developed, tests have been made of numerous toxic chemicals, especially compounds of sulphur, on the viability of winter sporangia in the soil, and light has been thrown on the nature of immunity by studying the reactions of tubers derived from plants built up of immune and susceptible portions by grafting.

(*c*) *Bacterial Diseases.*—It has been found that *Bacterium malvacearum*, which causes "Black-Arm Disease" of cotton, shows very complex cell-structure and passes through an involved life cycle both in pure culture and in the diseased plant. A study has been made of the black-arm disease by artificially infecting cotton plants growing under various strictly controlled environmental conditions, and it has been found that relative humidity and temperature are inter-related factors of primary importance in the development of the disease.

(*d*) *Insect Attacks.*—In general the effect of insect infestation is a direct destruction of portions of the plant to a stage that prevents it from developing normally, rather than any true physiological change. The general method of laboratory investigation is to work out the life history of the insect in question, with special attention to its most susceptible periods and the alternative host plants, in order that measures of control may be carried out at the most suitable periods. Especial attention has been given to the reproduction and migration of Aphides, more particularly those infesting Beans, and the Hop-Damson Aphis.

Control of Disease.—In addition to avoidance of disease by the development of immune varieties of plants, direct measures of control are employed, both against fungus diseases and insect attacks:—

Wart Disease of Potatoes.—The effect of finely divided sulphur thoroughly incorporated with the soil has been followed up in field experiments. The results are very variable and depend on climatic conditions and soil factors. The investigation has therefore been extended to include a study of the changes sulphur undergoes in the soil in varied conditions of temperature, moisture, and manurial treatment. A number of complex sulphur compounds are also being directly tested for their toxicity to Wart Disease.

Insecticides.—The insecticidal action of plant extracts and synthetic organic compounds is being studied both upon adult insects and their eggs, in an attempt to correlate chemical constitution and physical properties with toxic action on plant pests and disease organisms, and to find suitable compounds for use both as summer and winter washes. A large number of chemical substances are therefore being tested in the laboratory by means of a spraying machine devised to give quantitative comparisons of their contact insecticidal action. The most potent of the compounds are selected for trial in the field.

Quantitative investigations are being made of the insecticidal effect of stomach poisons and the tolerance of the foliage to them.

Special attention is being given to the plant pyrethrum (*C. cineriaefolium*). Experimental plots in different parts of the country have produced flowers having insecticidal properties equal to material grown abroad. The poisons have been isolated, one of

which has proved itself to be about the most toxic substance to insects so far tested. Methods for evaluation by chemical means have been worked out.

Biological Control.—Another possible method of controlling insect pests is by means of their parasites. This is of especial promise in newly developed areas where the insects may have been introduced recently, and, in the absence of their natural parasites, have multiplied unchecked. The procedure is to make investigations of any parasitised specimens found in the country of origin, and to devise suitable means for their transportation to, and liberation in the areas affected. Recent Rothamsted investigations have dealt with the control of earwigs in New Zealand by sending out parasites from England. The problem of studying the natural control of the frit-fly of oats by similar means has also been taken up.

Control of Noxious Weeds.—This is in a sense the complementary problem to insect control, the aim being to introduce suitable insects to attack weeds in regions where the latter have abnormally increased. In conjunction with the Cawthron Institute, New Zealand, an attempt is being made to check, by biological control, the spread of the bramble, ragwort and gorse in that country.

V. *Field Experiments.*

The advances in our knowledge of soil conditions and plant growth have necessitated corresponding improvements in the design of field plot experiments. It has become essential to have results that are not only more accurate than before, but to obtain them in a shorter time. The first step was to make a mathematical examination of the problem, taking into account the non-uniform or heterogeneous nature of the soil. It is now possible to lay down definite rules for the design of the experiment and the statistical treatment of the yield data under which results of known accuracy may be obtained.

The work has been further extended to a study of the effect of climatic factors. For this purpose the long series of records from the classical Rothamsted field experiments have been used.

The value of the newer system of field plot design is not confined only to increased accuracy of the yield figures. Quantitative observations are made on the plants throughout the season, of rates of growth, net assimilation, uptake of nutrients and maturation of the grain. This information throws light on the physiology of the response of the plant to manurial, seasonal and soil factors.

VI. *Other Activities.*

Apicultural Investigations.—Studies are being made of problems of practical importance to bee-keepers. Experiments on the winter feeding of bees with beet sugar and cane sugar indicate no unfavourable results from the use of the first-mentioned sugar. The use of

artificial "inverting" agents such as vinegar have been shown to be of no practical advantage. The value of increased packing of hives in winter is being studied, also the arrangement of the frames in relation to the hive front.

Facilities for Study and Research.

The Station is organised into the following departments :— Physics, Chemistry, Insecticides and Fungicides, Fermentation, Botany, Bacteriology, General Microbiology, Plant Pathology (Mycology), Plant Pathology (Entomology), Statistics.

There is also a field laboratory for studying new methods of field experiments.

The Station does not investigate problems outside the study of soil and the growing plant in health and disease ; *e.g.* no work is done on plant breeding, animal nutrition, agricultural economics, etc. The laboratories have been completely rebuilt within the past 10 years and the library containing books on agriculture and agricultural science is acknowledged to be one of the most complete in the world. The scientific staff is about 30, inclusive of post-graduate workers, scholarship holders, etc., conducting research work for the higher degrees mentioned below.

No fees are charged to voluntary workers for supervision of their work. Owing, however, to the high cost of apparatus, chemicals and other material a charge for these will be made either to the worker or to the authorities sending him to the Station.

Workers in Biological Departments are expected to bring a microscope or to pay a hire fee of £3 per annum.

Intending workers are requested to communicate in the first instance with the Assistant Director, stating the department in which they wish to work, and the probable length of stay.

Facilities offered to candidates for Research Degrees.

The University of Cambridge is prepared to give favourable consideration to each individual case of applicants who desire to carry out at Rothamsted a portion of their work for the Ph.D. Degree.

The University of London has accepted the Rothamsted Experimental Station as an institution from which research workers may submit work done at Rothamsted, under the supervision of Recognised Teachers of the University, for the following degrees :— M.Sc., Ph.D., D.Sc.

A brief précis of the most important conditions that must be fulfilled by candidates is given below for general guidance.

(1) *Cambridge.* Degrees are granted in full to men only ; under certain limitations the titles of degrees are open to women without some of the privileges which the degree confers in the University.

Ph.D.—A minimum residence of six terms at Cambridge and three at Rothamsted. Thesis normally to be presented not earlier than ninth term and not later than twelfth term from term of admission as a research student. In special cases permission may be sought to present the thesis after the twelfth term.

NOTE.—Three consecutive terms at Cambridge constitute a year.

(2) *London.* These degrees are open to men and women on equal terms.

M.Sc. and Ph.D.—A minimum residence of two calendar years at Rothamsted before submission of the thesis.

D.Sc.—Normally the candidate must first hold the M.Sc. degree of the University, but in special cases, on the ground of published work, this regulation may on application be waived. A minimum residence of two years at Rothamsted is required.

A student must ordinarily have taken his first degree not less than four years before the date of his entry for the D.Sc. examination.

NOTE.—In the case of students registering in October, the two-year period may be regarded as ending in the June of the second year.

Intending workers are strongly advised to send, in the first instance, a full account of their academic qualifications and training to the Assistant Director, as the candidate will be allowed to enter his thesis only if these qualifications are acceptable to the University authorities.

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(2) SOILS AND DRAINAGE DEPARTMENT. NORTH OF SCOTLAND COLLEGE OF AGRICULTURE AND UNIVERSITY OF ABERDEEN.

Laboratories situated at Marischal College, Aberdeen. *Nearest Railway Station:* Aberdeen. *Telephone:* Aberdeen 1096.

Lysimeters situated at Craibstone Experimental Farm, Bucksburn, Aberdeen. *Nearest Railway Station:* Bucksburn or Bankhead.

Staff.

Head of Department, Professor James Hendrick, B.Sc., F.I.C.
Soils Advisory Officer,
Assistant, Hugh D. Welsh.

Aims of the Department.

The Research Department is specially concerned with investigation into the properties and fertilisation of soils, and the losses

which manured and cropped soils suffer through drainage. The conditions and composition of Scottish soils, including moorland and peat soils and the requirements arising from the systems of agriculture followed in Scotland are particularly kept in view.

Summary of Work.

Soil Investigation.—The soils of Great Britain are mainly derived from the glacial materials left as a covering when the ice sheets and glaciers of the great ice age finally disappeared from the country. Investigations made at this centre have shown that the soils of the north and north-east of Scotland differ from most of the English and South of Scotland types in containing greater amounts of unweathered minerals and therefore greater reserves of lime, magnesia, potash and soda, the principal chemical bases necessary for plant life. Further study of Scottish soils showed that they were capable of subdivision according to the kinds of minerals which were predominantly present, and that the soil groups so formed were largely determined by the nature and composition of the parent material from which the soils arose. Another very common type of Scottish soil which is receiving attention has been reclaimed from moorland or peat and contains a large amount of peaty organic matter, Such soils are often very acid. They also are receiving special attention.

In addition to the influence of the parent material in determining soil types other factors such as climatic and other external conditions under which the soil has developed have to be taken into account. At present Scottish workers are engaged in an attempt to arrive at a scheme of classification which will assess the various factors at their proper value and prove satisfactory agriculturally. A soil survey will then be made recording the distribution of the several types by means of maps. With this object in view a programme of work for the study of soil features, as found in the field, has been entered upon. A study of their characteristics shows that the soils of Scotland belong to the group occurring in temperate and humid regions and that within this group are subtypes whose properties are determined by the kind of material from which they have developed and the local conditions of topography and vegetation under which they have developed.

Field study is supplemented in the laboratory by investigation of the mechanical and chemical composition of the soil. Recently a part has been taken in a revision of the British methods of mechanical and chemical analyses of soils, and in an international investigation as to the comparative merits of the methods adopted by various countries. Recent work on the question of the nature of the colloidal part of the soil has thrown fresh light on the problems of soil acidity and availability. Studies have been made of the colloidal matter and exchangeable bases of local soils by the new methods which have been devised and elaborated during recent years by well-known soil workers.

Lysimeter Investigations.—In order to obtain complete and exact information concerning what is leached from the soil by the water which passes through it, we require to know the amount of drainage which comes through the soil and its composition. When the experimental farm of Craibstone was acquired by the North of Scotland College of Agriculture it was decided to undertake drainage investigations and to construct a set of lysimeters. A set of three was constructed in 1914, each one-thousandth of an acre in area and forty inches deep, enclosed in slate slabs in such a way that the soil and subsoil are in the natural, undisturbed state. Suitable vessels are installed below in which the drainage is collected and measured. By means of these lysimeters the amount of the rainfall which percolates through the soil is measured. The main purpose of these lysimeters is to measure the amounts of lime, potash, nitrates and other constituents of value which are washed from the soil under the different conditions which are represented by the different plots, one of which is unmanured, another is manured both with dung and artificials, while the third is similarly manured and also limed. The lysimeters are all cropped in the same way as the surrounding field. Analyses of the drainage waters are made monthly and analyses of the crops grown and the manures applied are also made.

In addition to the regular analyses performed in connection with the lysimeter work determinations are made of substances brought down by the rain water which is collected alongside the lysimeters.

Numerous drainage investigations have also been made with small tanks artificially filled with soil and subsoil.

Facilities for Study and Research.

Advanced students have opportunities for carrying on study and research in the Department of Agriculture, Marischal College, and at the experimental farm at Craibstone on subjects connected with soils such as soil fertility and manuring, soil genesis, classification and mapping and soil drainage. Advanced study and research in Agricultural Entomology can also be carried on in Marischal College in the department of Zoology.

The Rowett Institute for Research in Animal Nutrition (*see* p. 80) is worked in connection with the University of Aberdeen and the College of Agriculture, and at it students can carry on research in subjects connected with animal nutrition. Students and research workers in such subjects can obtain facilities for advanced study in Physiology and Bio-Chemistry in the University and can obtain the use of the University Library.

Graduates of any approved University who study or carry on research in any of these departments can enter for the degree of Ph.D. The course for this degree usually covers three years, though in certain cases it may be reduced to two years.

Intending workers are requested in the first instance to communicate with the Director of Studies and Research, Agricultural Department, Marischal College, Aberdeen.

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(3) CHEMICAL [AND ANIMAL NUTRITION] DIVISION: MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

This Division is stationed at the Queen's University, Belfast.

Staff.

Head	R. G. Baskett, B.Sc.
Chief Assistant	F. Dickinson, B.Sc., F.I.C.
Assistant (*Dairy*) ..	J. Houston, M.Sc.
Assistant (*Soils*)	J. C. Baird, B.Sc., B.Agr.
Assistant (*Poultry Nutrition*)	J. H. Prentice, B.Sc., B.Agr.
Assistant (*Animal Nutrition*)	R. H. Cameron, B.Sc.

Summary of Work.

The research and experimental work of the Division falls into two main sections :—

1. Animal Nutrition.
2. Soil and Fertilizer Problems.

1. *Animal Nutrition*, see p. 85.

2. *Soil and Fertilizer Problems* :—

An investigation carried out during the years 1921–26 inclusive as to the relative value of ground mineral phosphates compared with high grade basic slag, superphosphate and other phosphatic fertilizers has been completed and a report has been published (*Journ. Min. Agric. N. Ireland, Vol.* 1).

A series of experiments has been carried out on various crops to compare the relative values of several nitrogenous fertilizers, and in particular chloride of ammonia and urea as sources of nitrogen. This work has been extended with a view to checking the soundness of the mixture of artificials recommended to potato growers in Northern Ireland. Field experimental work is also in hand with Nitrophoska of British and of German origin.

Soils.—Field experimental work, commenced in 1924, is being continued with the object of ascertaining whether soil acidity as measured by the hydrogen ion concentration or/and the lime requirement figure affords a practical indication of the need for lime in North of Ireland soils. An extensive acidity survey of the Experimental Farm at Hillsborough is in progress. Preliminary results show a rather wide range of acidity. It is proposed to lay down a series

of lime plots on each of the fields and to follow out the effect of the dressing (*a*) on the soil, (*b*) the crop yields and (*c*) the mineral content of the crops and herbage.

Facilities for Advanced Study and Research at the Queen's University of Belfast.

Faculty of Agriculture.

The Faculty has recently occupied new buildings specially designed for the purposes of the various departments and fully equipped with modern fittings and apparatus.

Laboratories.—Extensive laboratory accommodation is available in the main building for study or research in animal nutrition, soil chemistry, dairy chemistry, dairy bacteriology and agricultural botany, including plant pathology. The official seed testing and milk testing stations are also housed in the building. Suites of laboratories recently fitted for research in animal pathology and in plant breeding are open to students in a separate block at Stormont.

Plant Breeding Station.—In connexion with this Station a large cage of up-to-date construction is in use and is surrounded by a five-acre area of good cultivated land devoted to field scale plots. The buildings are equipped with modern threshing and seed cleaning plant.

Animal Diseases Station.—In addition to laboratories the Station is provided with extensive cage and loose-box accommodation for small and large animals under experiment.

Poultry Research Station is situated at the Experimental farm at Hillsborough. The plant is designed solely for experimental purposes. Provision is made for the hatching and rearing of 3,000 chickens and for the accommodation of 1,000 laying birds in 40 experimental groups of 25 birds.

Research Station.—An agricultural research station for crops and stock is in operation at Hillsborough, County Down. The farm extends to 500 acres. The farmsteading is rebuilt and modernized and furnished with up-to-date machinery. The Station is primarily intended for research in animal nutrition, and the byres, boxes, poultry plant, etc., are designed mainly for that purpose, but land and buildings are also available for crop investigations.

Higher Degrees.

Master of Agriculture.—This degree is open, after not less than two years, to graduates admitted by the Senate *ad eundem gradum.*

Master of Science.—May be conferred upon graduates similarly admitted after not less than one academic year.

Doctor of Philosophy.—Graduates of an approved University may make application to be examined for Ph.D. after not less than two years' study or research (if full time be devoted thereto). Candidates may be permitted to spend the second year elsewhere at the discretion of the University.

Doctor of Science.—Any graduate of the University may make application to be examined for this degree three years after graduation.

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(4) ROYAL BOTANIC GARDENS, KEW.

Nearest Railway Stations : Kew Gardens, District Railway, and L.M.S.
Kew Bridge, S.R., and L.M.S.

'Buses : 27 and 291 from London pass several gates of the Gardens.

Staff.

Director	A. W. Hill, C.M.G., M.A., Sc.D., F.R.S., F.L.S.
Assistant Director	T. F. Chipp, M.C., D.Sc., Ph.D., F.L.S.
Economic Botanist	H. C. Sampson, C.I.E., B.Sc.
Curator	W. J. Bean, I.S.O.
Herbarium & Library : Keeper	A. D. Cotton, F.L.S.
Museums : Keeper	W. Dallimore.
Jodrell Laboratory : Asst. Keeper	L. A. Boodle, A.R.C.S., F.L.S.

Aims.

The Royal Botanic Gardens, Kew, are the centre for systematic and economic botany within the British Empire, and plants of economic importance are grown in the Gardens and sent out to various parts of the Empire. In the Gardens generally an attempt is made to grow all plants of horticultural, botanical and economic interest, which can be grown in the neighbourhood of London both in the open and under glass.

There are four principal divisions: the Gardens proper, the Herbarium and Library, the Museums and the Laboratory. Work in the Herbarium is concerned with the working out of floras in the British Empire in particular, and Floras of the different parts of the Empire have been prepared at Kew. At the present time the Flora of West Tropical Africa is under publication, and work is also being undertaken in connection with pasture grasses of East Africa. The following Floras relating to the British Empire have been prepared at Kew :—

Flora Australiensis.
Flora Capensis.

Flora of the British West Indian Islands.
Handbook of the New Zealand Flora.
Handbook of the Flora of Ceylon.
Flora Hongkongensis.
Flora of Mauritius and the Seychelles.
Flora of Tropical Africa.
Flora of British India.
Floras of Bermuda, St. Helena, Ascension, Tristan da Cunha.
Useful Plants of Nigeria.

In addition to the large collection of dried specimens of plants contained in the Herbarium there is a large collection of seeds, systematically arranged, by the help of which it is possible to identify almost any plants that may be sent to Kew. It is also possible to give a great deal of assistance to fossil botanists working on seeds found in recent geological formations.

In the four Museums the economic products derived from the vegetable kingdom are displayed, and information can be given at Kew with regard to economic products which may be sent for examination from almost any part of the world.

Facilities are granted at Kew for working in the Herbarium, Museums or Laboratory to any botanists who may desire to avail themselves of the opportunities afforded, and applications should be addressed to the Director.

The original scientific work by officers attached to the staff is published in the Kew Bulletin, which is issued in ten parts in the course of a year.

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(5) RESEARCH INSTITUTE IN PLANT PHYSIOLOGY: IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY LONDON.

The Research Institute, which is associated with the Botany Department of the Imperial College, stands on the north side of the west end of Prince Consort Road, South Kensington. The nearest, and equidistant, stations are those of Gloucester Road and South Kensington on the District Railway. *Telephone:* Kensington 7118.

Staff.

Director.—Professor V. H. Blackman, Sc.D., F.R.S.

Graded Staff.—R. C. Knight, D.Sc., F. G. Gregory, D.Sc., B. D. Bolas, M.Sc., F. J. Richards, B.Sc.

Aims of the Institute.

The work of the Research Institute in Plant Physiology is mainly directed to the elucidation of the plant physiological processes

responsible for crop yield in the field and under glass. The Institute works in close association with the Research Institutes at Rothamsted, Cheshunt, and East Malling. A few of the more recent investigations carried out by the Institute are indicated below.

Summary of Work.

Physiological Analysis of Manurial Effects.—The analyses of the manurial effects of the salts on the growth of barley has been extended to include potash, the effects of seven concentrations of potassium sulphate being studied. Samples were taken every fortnight throughout the growing season, and the usual measurements of leaf area, dry weight, and tiller number were made. The effects of nitrogen, phosphate and potash in different concentrations can thus be compared in their average effects over the whole growth period or at any stage of growth. The effects on grain production can also be studied in relation to number of ears produced, average number of flowers per ear, and percentage fertility of the flowers present. The relations of vegetative growth and grain production with different concentrations of manure can also be obtained.

A preliminary investigation has been carried out on the effect on growth and yield of barley of the time of addition of nitrogen and phosphate, alone and in combination.

A start has been made on the problem of analysis of the physiological factors underlying the difference in yield of barley varieties, the work being conducted both in the field and in the laboratory.

An investigation has also been conducted into the effect of manuring on the strength of straw.

Effect of Meterorological Conditions on Plant Growth.—The dominant factor in plant yield is that set of climatic conditions known as "weather," and the effect of these has been studied by growing plants in the open and recording their growth throughout the season, while at the same time careful records are made of the light, temperature, humidity and other conditions. A statistical comparison of the variation in the physiological processes of the plant on the one hand, with the concomitant changes in the weather on the other hand, gives a picture of the effect of the different external conditions on the growth and development of the plant. With barley growing in the open the physiological processes studied were the assimilation rate (*i.e.*, the net uptake of food material by the leaves), the relative rate of increase of plant material (*i.e.*, the rate at compound interest at which the dry weight of the plant increases), and the relative rate of growth of the leaf surface. The results indicate very clearly the physiological adaptation of the plant to climatic changes. It is found that the rate of food production, and accordingly the rate of growth, is kept singularly constant whether the conditions are of high light intensity, as in a bright summer, or low light intensity, as in a dull summer. This relative constancy is

due to the fact that while bright light reduces the rate of leaf-growth, the total leaf surface, though smaller, acts more efficiently in the bright light available. In a dull light, on the other hand, the leaf surface is larger but area for area less effective. The plants thus maintain a fair level of activity in spite of widely fluctuating weather conditions. It is found also that low night temperatures are favourable to the accumulation of food material by the plant, as they reduce the wasteful consumption of material in respiration, for the rate of this process rises and falls with the rise and fall of temperature.

Electroculture.—The Institute has also been engaged for some time in a study of the effect of electric discharges on crop-yield. The work has for the last few years been carried out by means of pot-cultures, since the experimental error can in this way be reduced to small dimensions and significant results obtained much more quickly. The data obtained show clearly that minute electric currents supplied from overhead networks cause a definite increase in the yield of barley. An analysis of this increased yield indicates that it is generally independent of any increase of vegetative growth, but the ears of the electrified plants show a larger proportion of fertile flowers than do those of the control plants. There are indications also that the effect is closely associated with the quality and quantity of fertiliser given. The experimental work has not yet reached an economic stage, but the electrical effect is undoubted.

Change of Seed in Potatoes.—The question of the necessity for "change of seed" in potatoes has also been under investigation. Potatoes have been grown for several years in succession, and a comparison made between yields from fresh Scotch seed and from "home grown" seed one year old, two years old, etc. No evidence was obtained, at least within a period of a few years, of the commonly accepted "physiological degeneration." If the crop is kept free from virus diseases the yield from "thrice-grown" seed may be as high or higher than that from fresh Scotch seed.

Carbon Dioxide Investigation.—The effect of changing the concentration of carbon dioxide of the air is now under investigation. It has often been claimed—and the effect is an undoubted one—that increase of the supply of this gas (which is the main food supply of the plant) will increase the growth of crops. The effect is of importance in the glasshouse industry, but hitherto there has been no serious physiological study of the problem and the question of the most suitable concentration to be supplied is still unknown. A preliminary study has already shown that, with cucumbers, increases in dry weight of 80 per cent. can be obtained in a few weeks by increasing the concentration of carbon dioxide from the normal 3 parts in 10,000 to 15 parts.

Other problems under investigation have been a study in association with the East Malling Research Institute of the rooting of

cuttings, of apple stocks, and of the effect of stem pruning on the subsequent growth of root and shoot.

Facilities for Advanced Study and Research.

For Advanced Study.—Members of the staff give advanced courses of lectures on the physiology of plants. Advanced students may also attend lectures and practical courses in the Departments of Biochemistry, Plant Pathology, and Bacteriology.

For Research.—The Institute is well equipped for research in general plant physiology and in chemical physiology. There are also opportunities for research work in the physiology of fungi. A room with controlled temperature is available and also refrigerators for undertaking physiological work on the effect of low temperatures upon plants. The laboratories are particularly well equipped on the chemical and electrical side, and for experiments on the growth of plants under artificial light and controlled conditions of temperature. Facilities for field work and pot-culture work in relation to plant physiology and pathology are available.

Degrees and Diplomas Available.

(i) Graduates of other universities who have had a suitable training can enter for the Diploma of the Imperial College for which a thesis must be presented representing work covering a minimum period of one year.

(ii) Graduates of other universities with qualifications similar to the above may be registered for the M.Sc. or Ph.D. degrees of London University for which they must present a thesis representing work covering a minimum period of two years.

(iii) In certain cases the D.Sc. degree of London University is open to suitably qualified candidates, though usually the student must have first taken the M.Sc. degree of the University. Students, however, who have already published work to their credit may be exempted from the lower degree.

Admission.—Requests for admission to the Institute should be sent to the Director together with a full account of the academic qualification and training of the applicant. Registration for degrees (M.Sc., Ph.D., and D.Sc.) of London University depends upon the qualifications of the candidate, the decision as to registration resting with the University authorities.

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(6) PLANT BREEDING INSTITUTE: CAMBRIDGE UNIVERSITY.

The experimental grounds of the Plant Breeding Institute are on the University Farm, Huntingdon Road, Cambridge. These are equipped with bird-proof cages for the protection of the more

important hybrid cereals at various stages of growth and during their earlier yield trials; with greenhouses, storage rooms and a small machine room for threshing and seed cleaning. The larger plots are handled almost entirely on the Farm, whilst the produce of the smaller plots, for instance of cereals at the F_2 and F_3 stages, is transferred to the School of Agriculture, Cambridge, for more detailed examination. There a general sorting room, a chemical laboratory, and a mill room have been fitted up as well as rooms for the research staff. *Telephone:* Cambridge 1885.

Staff.

Director	Prof. Sir R. H. Biffen, M.A., F.R.S.
Assistant Director ..	F. L. Engledow, M.A.
Assistant	H. Hunter, D.Sc.
Assistant	A. E. Watkins, M.A.

Special Staff for Virus Diseases of Potatoes.

Assistant Director ..	R. N. Salaman, M.D.
Entomologist	K. Smith, D.Sc.

Aims of the Institute.

The main work of the Institute centres round the problem of breeding improved types of the plants cultivated as farm crops in this country. The general plan with each of the crops under investigation is to collect together all available varieties and make a preliminary study of the mode of inheritance of all of their more important characteristics with the object of systematizing the investigations and leaving as little as possible to chance. Any promising new forms obtained are given critical small-scale tests and if found satisfactory are handed over to the National Institute of Agricultural Botany for large scale tests, multiplication and distribution.

Summary of Work.

Up to the present most progress has been made with the cereal crops and a considerable number of new forms of wheat, barley and oats are now awaiting field trials and multiplication.

Wheat.—The chief problems associated with the improvement of wheat are concerned with the production of (*a*) forms better suited for bread-making than those generally grown in this country, (*b*) rust and mildew resistant forms, (*c*) forms more suitable for intensive cultivation and (*d*) rapidly maturing types for spring sowing. In addition a cytological investigation on crosses between races of wheats differing in their chromosome numbers is in progress.

Barley.—The two main lines of investigation with the barley crop have as their object the production of better forms for feeding and for malting purposes. The work has again involved an examina-

tion of the possibility of breeding for resistance against such diseases as mildew and *Helminthosporium* and a detailed examination of several problems associated with malting quality. A series of six-rowed barleys suitable for autumn sowing has recently been raised and is now under trial under ordinary farming conditions.

Oats.—The chief problem with the oat crops is the production of satisfactory winter hardy forms. After a long-continued comparison of existing forms work has been concentrated on hybrid derivatives of the grey winter oat and a number of these have been tested out during the past two seasons. Progress is also being made with the breeding of spring oats.

Other Crops.—Preliminary work on the possibilities of improving beans, peas, lucerne, sugar beet, kohl rabi, marrow stem kale, cabbages and other brassicae, is also being carried out.

The task of raising stocks of seed potatoes free from various virus diseases has recently been undertaken by the Institute.

Facilities for Advanced Study and Research.

In addition to facilities for investigating the genetics of most crops and the application of genetical principles to crop improvement, facilities for research work in the following subjects are available :— Virus diseases of plants, more especially of potatoes ; methods for testing the yielding capacity of crops ; factors affecting yield ; winter hardiness in barley and oats ; the quality of wheat for such purposes as bread, biscuit and pudding making ; disease resistance, and the cytology of " interspecific " crosses, chiefly amongst cereals.

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(7) WELSH PLANT BREEDING STATION, UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH.

The Station is situated at Aberystwyth, Cardiganshire (G.W.R., about 6 hours from Paddington and 2½ from Shrewsbury). The laboratories are at the Agricultural Buildings nearly opposite the railway station. The gardens (5 acres) are on the outskirts of the town (¼ mile distant) and the farm (Frongoch, 96 acres) is distant about 1¾ miles from the laboratories. Postal address, Agricultural Buildings, Alexandra Road, Aberystwyth. *Telephone :* Aberystwyth 105.

Staff.

Director	Professor R. G. Stapledon, M.B.E., M.A.	
Plant breeding and Genetics.	T. J. Jenkin, M.Sc.,	in charge of grasses.
	R. D. Williams, M.Sc.	,, ,, ,, clovers.
	E. T. Jones, B.Sc.	,, ,, ,, oats.
Agronomy	William Davies, M.Sc.	,, ,, ,, grass-land.

Plant Pathology .. Miss K. Sampson, M.Sc.
D. Walters Davies, B.Sc.

Plant Physiology .. Vacant.

Aims of the Station.

The aim of the Station is to conduct researches in relation to plant breeding in a manner most likely to benefit farmers occupying areas in high rainfall districts and at high elevations, and generally under conditions of low and relatively low fertility.

Chief attention is therefore given to herbage plants ; and researches are also being conducted on the whole question of the management of grassland, particularly temporary grass. Of ordinary arable crops, oats is the only one which is receiving serious and critical attention at the Station from the point of view of plant breeding and of agronomy.

Summary of Work.

The work that has been undertaken and that is in progress and which is likely to be of the greatest interest from the Imperial point of view may be briefly summarised as follows :—

Herbage Plants : breeding.—The chief species under review are Italian and perennial rye-grasses, cocksfoot, timothy, the fescues, tall oat grass and *Phalaris spp.*, red clover, white clover, subterranean clover and lucerne. It will be noted that these are species having a wide applicability over vast areas within the Empire. Of added interest is the fact that in the case of several of the species the material under study represents types and strains collected from all parts of the world. A great deal of work has been conducted on the technique of breeding these cross fertile plants. Large populations derived from selfed plants are under review and interesting results have been obtained on cross and self fertility and productivity. In the case of cocksfoot and red clover, a mass of evidence has been collected relative to ecotypical selection, and very instructive living material is at present under study.

Hybridization and genetical work has proceeded some way in respect of red clover, lucerne, the rye-grasses and tall oat grass—while the inter-specific crosses achieved between some of the grasses afford very interesting material for study.

Herbage Plants : agronomy.—The ratio leaf to stem of the different species under varied conditions of management is a matter which has received considerable attention ; as has persistency and tiller production. A technique is being developed for studying the relationship between the animal complex (in this case sheep) and the pasture complex, and these studies are being supported by chemical evidence. The fundamental questions affecting the choice of seeds mixtures and putting land down to grass are important topics of study at the Station : matters under review are soil establishment ; the com-

petitive influences of the different species on each other in relation to different systems of management, and the behaviour of different strains of one and the same species in seeds mixtures.

Cereals : breeding.—The work has concentrated on endeavours to produce a white and highly hardy winter oat, and good standing varieties of oats suitable for hilly districts and high rainfall. The question of forage oats is also under consideration, and a large number of varieties are under study with a view to subsequent hybridization work. Inter-specific crosses have been made between *Avena brevis* and *A. strigosa* with a view to getting a hardy oat with a better grain character than the latter, and interesting material is under review.

Cereal diseases.—In order to try to get an oat of the potato character resistant to crown rust, crosses have been made with the Scotch potato variety (*A. sativa*) and red rustproof (*A. sterilis*), and these too afford interesting material. The effect of bunt fungus of wheat on yield has been studied. The dry treatments (copper carbonate and the like) have been and still are extensively studied at the station.

Cereals : agronomy.—These studies are concerned chiefly with yield in relation to (*a*) early, medium and late varieties at high and low elevations and in sympathy with climatic conditions ; (*b*) in relation to the source of origin of the parent seed and the conditions under which the seed was grown and harvested.

Physiology.—Work has been in progress for the last three years with reference to the effect of the duration of daylight on the flowering and fruiting of plants. These studies have special relation to the question of the hybridization of strains which do not normally flower together.

Critical studies are being initiated during the present season bearing upon the action of nitrogenous fertilisers on plants kept more or less continuously defoliated ; a large number of plants will be under review during the current season.

A large number of herbage trials are conducted on farms in the district, many of which are within easy motoring distance of Aberystwyth. A number of trials are also carried out in conjunction with the Agricultural Department at the College Farm (Nantcellan), distant 3 miles from the laboratories.

Facilities for Advanced Study and Research.

In addition to facilities for investigating the genetics of herbage plants and of oats, facilities for research work in the following subjects are available : the general ecology of grasslands, problems connected with seeds mixtures and the management and manuring of grasslands ; methods of testing the yielding and other properties of oats and herbage plants ; factors affecting palatability, yield, winter

hardiness and persistence in grasses and clovers ; the disease relationships of the species under detailed study at the Station.

The Institution is well equipped with means for research in the above subjects. The equipment includes laboratories, garden and field experimental grounds with an extensive range of glass and cultural houses.

Members of the staff of the Institution give advanced courses of lectures in connection with the problems under study at the Station.

Admission. (1) Graduates who can spend some time at Aberystwyth may be admitted to the course of study for the Ph.D. degree, which normally covers two years. Candidates for the degree are placed under the direct supervision of a senior member of the staff, who is responsible for directing their research.

(2) Members of the staffs of Research or Teaching Institutions and of Government Departments of Agriculture may be given permission to work at the Institution for shorter periods, but it is not at present possible to obtain any diploma or degree in a shorter period than that required for the Ph.D.

Requests for admission should be directed to The Director, Agricultural Buildings, Alexandra Road, Aberystwyth, as long as possible before proposed arrival in Aberystwyth.

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(8) SCOTTISH SOCIETY FOR RESEARCH IN PLANT BREEDING.

The Scottish Plant Breeding Station is situated near Corstorphine, Midlothian, and is about five miles distant from the General Post Office, Edinburgh. The nearest Railway Station is Corstorphine, L.N.E.R., distance about 1½ miles. *Telephone :* Corstorphine 81.

Staff.

Director of Research	William Robb, N.D.A.
Chief Assistant (*Potatoes and Herbage Plants*)	Jas. W. Gregor, Ph.D.
Assistant (*Potatoes*)	William Black, B.Sc.
Assistant (*Swedes and Turnips*) ..	V. E. McM. Davey, B.Sc.

Aims of the Society.

The aims of the Society are to establish a thoroughly equipped station and to promote the discovery and the creation of such new and improved races of the leading crop plants as are best suited to Scottish conditions.

The methods employed at the Station to obtain improved types of plants are, in the main :—

(*a*) Collection and classification of suitable living material.

(*b*) Isolation of pedigree strains (pure lines).

(*c*) Hybridisation of pedigree strains, varieties, and species.
(*d*) Comparative trial of varieties, pedigree strains, &c.

Summary of Work.

Oats.—The main objects of the breeding experiments with oats are (*a*) to evolve improved types or strains of the old-established and well-known varieties, namely, Potato, Sandy, and Tam Finlay, (*b*) to evolve stiff-strawed, heavy grain yielding varieties of oats which will not lodge readily on rich soils.

Hybridisation on an extensive scale has been resorted to as a means of obtaining the desired results. Within the last few years attention has largely been concentrated on hybridising several early-ripening Australian and Swedish oats with some of the standard Scottish varieties. The progenies of the various hybrids that have been obtained are being studied and observations made that will assist in selecting plants breeding true to type. Notes are also made with reference to the segregation of various botanical characters. After promising varieties are isolated, each variety is multiplied and compared with certain standard named varieties in " centgener " and " rod-row " plots. The least promising ones are discarded and the others are further tested and multiplied in field plots. Samples of the latter varieties are also sent to the Plant Registration Station, Board of Agriculture for Scotland, and to several different localities in Scotland to be tried on a field-scale in order to obtain data regarding their performance under a wide range of conditions.

Potatoes.—The work with potatoes includes investigations into (*a*) the heredity of several characters, (*b*) the effects of selfing in obtaining relatively pure-breeding parent varieties, (*c*) the relative merits of various pairs of varieties as parents for producing new immune varieties of economic value.

The potato breeding experiments are carried out at two different centres—the breeding of seedlings at the Society's Sub-Station at an upland farm near Kirknewton, Midlothian, and the field-trials of seedlings at the Plant-Breeding Station, Corstorphine. The purpose of raising the seedlings at the Sub-Station, where a considerable measure of isolation from other potato crops exists, is to avoid, as far as possible under field conditions, the transmission of virus diseases to the seedlings in the early stages of growth.

Through arrangements made with the Plant Registration Station, Board of Agriculture for Scotland, whole families of seedlings in addition to selected seedlings, are tested for immunity from wart disease, to obtain further information regarding the heredity of immunity from wart disease in various hybrids and selfed strains.

Herbage Plants.—The purpose of the investigations on the herbage plants—perennial ryegrass, cocksfoot, and timothy—is mainly to obtain information that will lead to the construction of a sound system of breeding and of comparing pasture types of the

above-mentioned grasses. The investigations include studies of (*a*) self-sterility in grasses, (*b*) the genotypic composition of wild populations of perennial ryegrass, and (*c*) the effects of different environmental conditions on various species and strains of grasses

The method of breeding which is being pursued for the present is to hybridise plants similar in form (phenotypes) and preferably those from the same population.

The problem of multiplying comparatively pure strains of perennial ryegrass is receiving attention.

Swedes and Turnips.—The problems under investigation were chosen mainly to obtain information which will lead to improved methods of breeding being devised.

The heredity of characteristics such as shape of the "root," skin colour of the "root," dry matter content, "bolting," and resistance to finger-and-toe disease is being studied.

Observations are being made on the results of self-fertilisation of swedes through a number of generations in an endeavour to produce strains that will breed true to type for several characters which, in many commercial varieties, appear to be unfixed.

A start has been made to explore the possibilities of selecting parent roots on the basis of the amount of "soluble-solids" contained in the root.

Several pedigree cultures of swedes are being grown in soil infected with the finger-and-toe organism to discover whether any of the cultures show a high degree of resistance to finger-and-toe disease.

Facilities for Study and Research.

At the Scottish Plant-Breeding Station, Craigs House, Corstorphine, Midlothian, research is beingconducted with a view to improving crops such as oats, potatoes, swedes and certain grasses. Facilities are available for carrying out genetical work and for the application of genetical principles to the improvement of these crops. It is hoped that in the near future facilities may also be available for research work concerning virus diseases of potatoes.

Requests for permission to undertake research work at the Scottish Plant Breeding Station should be made to the Director of Research there as long as possible before the applicant proposes to start work.

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(9) PLANT BREEDING RESEARCH DIVISION: MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

This Division is situated at Stormont, Strandtown, 5 miles from Belfast on the Dundonald tramway line.

Staff.

Head of Division	Ian W. Seaton, B.Sc.
Assistant	E. V. B. Wilson, B.Sc.

Aims of the Division.

This Division is concerned with the production of improved varieties of the agricultural crops of Northern Ireland, of which the most important are oats, potatoes, flax, roots and ryegrass. Oats annually occupy the greatest acreage, and consequently most time hitherto has been devoted to this crop. The results aimed at in work on oats are :—

(1) Improvement upon existing varieties as the outcome of breeding work. It is hoped that improved yields may result from the introduction of new varieties produced by the Division. Characters being particularly studied in this connection are :—

Winter hardiness in relation to grain colour.
Tillering capacity.
Earliness of maturity.
Strength and quality of straw.

(2) The determination of the most suitable existing varieties by variety trials. It is found that there is considerable variation in this respect from district to district, which variation is probably to be correlated with varying climatic conditions. This necessitates the identification of the environmental conditions which influence this variation within varieties. The practical result hoped for here is that improved yields may be obtained by the intelligent " fitting " of varieties to districts.

In flax the objectives are improved yield and quality of fibre.

Facilities for Study and Research.

See p. 24.

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(10) NATIONAL INSTITUTE OF AGRICULTURAL BOTANY.

(Including the Official Seed Testing Station for England and Wales.)

The Offices, the Official Seed Testing Station for England and Wales, and the Headquarters Trial Ground are situated on the Huntingdon Road, 3 miles from Cambridge Station (L.N.E.R.), and can be reached by a frequent service of buses, Service No. 1 from the Station to Market Street and No. 2 from Market Street to the Institute. *Telephone :* Cambridge 1001.

The Institute also has a Potato Testing Station at Lathom Lane, Ormskirk, Lancs., the nearest Station (1 mile) being Ormskirk

(L.M.S.R.), with frequent trains from Liverpool, Southport and Preston.

There are also sub-stations for field trials at Sprowston, nr. Norwich ; Good Easter, nr. Chelmsford ; Long Sutton, nr. Basingstoke ; Cannington Court, nr. Bridgwater ; and Newport, Salop.

Staff.

Director : W. H. Parker, M.C., M.A. ..	Administrative and Crop Improvement Work.
Secretary and Assistant Director : F. C. Hawkes, M.A.	
Manager of Field Plots : S. F. Armstrong, M.A.	Crop Improvement Work.
Assistant to Manager of Field Plots : E G. Thompson, M.A.	
Chief Officer, Official Seed Testing Station : A. Eastham, D.S.O., M.C., B.Sc.	Seed Testing.
Assistant to Chief Officer : C. C. Brett, M.A.	
Assistant to Chief Officer : R. A. Finlayson ..	
Superintendent of Potato Trials : H. Bryan, B.Sc.	Potato Trials and Diseases.

Aims of the Institute.

The Institute's aim is to improve the yield and quality of farm crops. It is organised for this work in three main branches :—

(*a*) Crop Improvement Branch, which affords facilities for the field testing of old and new varieties of agricultural plants and the marketing of new ones.

(*b*) Official Seed Testing Station for England and Wales, which tests seeds for purity and germination, examines seeds for certain diseases, and undertakes research work in connection with seed problems.

(*c*) Potato Testing Station, Ormskirk, where wart disease immunity trials, yield and maturity trials, and virus disease investigations are carried out, and varieties growing on the trial plots are examined for "synonymity."

Summary of Work.

Crop Improvement.

The main work of the Crop Improvement Branch is to provide agriculturists with authoritative reports on the yield and quality of old and new varieties of the principal farm crops, and on their suitability for the various soils and climatic conditions of England. The present trials, begun in 1924, cover wheat, oats, barley, beans, mangolds, swedes, sugar beet and lucerne. The trials take place at

Cambridge and five sub-stations, chosen to represent different soil and climatic conditions, and they are supplemented by an extensive range of observation plots at each centre. In view of the vagaries of the English climate it is usually necessary to retain each variety in the trials for three seasons, but as soon as enough has been learnt about any variety its place is taken by a newcomer chosen from the more promising of the varieties under observation. In this way the merits and defects of all the leading varieties of the present day and the new productions of plant breeders will gradually be registered for the public benefit.

To determine the relative yielding capacities of the varieties a method of field trial devised by Dr. E. S. Beaven is used. This secures the required degree of accuracy without departing from normal methods of cultivation ; and as there is at least a quarter of an acre of each variety, the method provides reliable data on such points as strength of straw or disease-resistance under field conditions. Quality is determined by laboratory analyses and practical tests—the National Association of British and Irish Millers mill and bake the wheats, and the Institute of Brewing malts the barleys.

Arrangements have recently been made in Essex to give a wider application to the results of these trials by collecting records from farmers of the behaviour of the same varieties under ordinary agricultural conditions, and the co-operation of agricultural organisers has been secured in collecting observations on varieties grown in their respective counties.

If a new variety is proved by the trials to be of outstanding merit the Institute will, where the breeder wishes it, undertake to launch it on the market. Thus in 1924 the Institute marketed through the seed trade a large bulk of an improved wheat, Yeoman II, from the Cambridge Plant Breeding Institute.

Of the minor activities of the Crop Improvement Branch the most interesting to visitors is the collection of cereals, some four to five hundred of which are grown every year at Cambridge.

Official Seed Testing Station for England and Wales.

The primary duty of the Station (which is managed by the Institute for the Ministry of Agriculture and Fisheries) is to test in the laboratory for purity and germination samples of seeds sent by merchants to enable them to comply with the Seeds Act, or by farmers who wish to check for themselves the quality of the seed they propose to sow. The Seeds Act provides that in the case of the principal kinds of agricultural seeds the seller shall declare the proportions of pure and viable seed and the presence of any injurious weed seeds there may be in the bulks that he is offering for sale. Many of the larger merchants are licensed to test their own stocks, but the Station receives from 25,000 to 30,000 samples a year. These include some 2,000–3,000 control samples taken by inspectors of the Ministry

of Agriculture to check the accuracy of the work of the private licensed stations.

A number of special investigations into the problems that arise from seed testing are always in progress. Some are directed to solve difficulties in the technique of seed testing, others to discover what deductions of immediate value to farmers and seed merchants can be drawn by examination from different points of view of the mass of material that passes constantly through the Station. All serve to swell the store of specialised information on which increasing calls are made by other research workers, seed testing stations, farmers and merchants. Among the subjects now under investigation are the rate at which seeds lose their vitality under different conditions of storage ; the relation of laboratory tests to germination in the field ; the value of " hard " seeds, broken seeds, and broken growths ; improved methods for germination tests of various classes of seeds ; means of identifying some of the finer grass seeds ; the causes for the rapid deterioration of New Zealand Dogstail and Chewings Fescue during the sea voyage ; means of distinguishing wild from Dutch White Clover seed ; questions of provenance and the prevalence of seed-borne diseases and the improvement of preventive methods. The last is a subject of growing importance, and the Station already undertakes, as a matter of routine, examinations of wheat samples for the presence of bunt spores, peas for marsh-spot, and celery seed for leaf-spot.

A four weeks' course of instruction and an examination in seed testing are held at the Station every summer.

Potato Testing Station, Ormskirk.

At its Potato Testing Station the Institute conducts annually for the Ministry of Agriculture trials of new potato varieties for immunity from wart disease. To be certified as immune a variety must be grown at Ormskirk and remain free from wart disease for at least two years. A small entry fee is charged and some 250 plots are grown in infected soil every year. The field plots are now supplemented by greenhouse tests on lines suggested by the Rothamsted Experimental Station.

Wart disease trials in miniature—the " Susceptibility Trials "—are undertaken without fees to meet the needs of students of genetics and breeders. Entries vary from 600 to 2,000.

Virus disease investigations nowadays bulk largely in the Station's programme. At present they consist of :—

(*a*) The relative susceptibility to leaf-roll of stocks of six popular varieties from several districts ; and the possibility of combined trials for resistance to virus diseases and wart disease.

(*b*) The possibility of growing virus-free seed over a period of years under Lancashire conditions.

(*c*) The possibility of building up a healthy stock from a diseased variety.
(*d*) Demonstration plots of virus diseases.

Other work at Ormskirk includes the trials for the Lord Derby Gold Medals—these are awarded to new immune varieties of outstanding promise; yield and maturity trials of the leading main crop varieties—these are repeated in Lincolnshire and Cornwall "early bulking" trials; and demonstration plots of all varieties that interest British growers.

All the stocks sent for trial to Ormskirk are examined twice each year by the Potato Synonym Committee, who report which are new and distinct varieties and which are only old varieties masquerading under new names.

Facilities for Study and Research.

The Institute offers facilities for the study of two subjects :—

(*a*) Crop improvement work including potatoes, and
(*b*) Seed testing.

(*a*) Although no actual course of instruction is held in crop improvement work facilities are given to approved workers in order that they may gain an insight into the Institute's methods.

(*b*) In addition to the Seed Testing Course held annually at the end of June and lasting for about one month, the Official Seed Testing Station is prepared to offer special facilities for instruction in all phases of Seed Testing and problems arising therefrom to students approved by the Chief Officer of the Station.

All applications should be made to the Director of the Institute.

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(11) SEED TESTING AND PLANT REGISTRATION STATION: BOARD OF AGRICULTURE FOR SCOTLAND.

Location.—East Craigs, Craigs Road, Corstorphine, Edinburgh.

Postal Address.—East Craigs, Corstorphine, Midlothian.

Nearest Railway Station.—Corstorphine—L.N.E.R.—1½ miles.

Nearest Tram Terminus.—Corstorphine, 1 mile.

Telephone : Corstorphine 83.

Staff.

Director	Thomas Anderson, M.A., B.Sc. (Agric.) (Edin.). Agricultural Botanist.
Chief Assistant, Seed Testing Station ..	George Gilray.

Inspector (attached) (Supervisor of Potato Experiments)	Adam Millar, B.Sc. (Agric.) (Edin.).
Assistants	Rachael K. Stoddart. Charlotte G. Simpson.
Farm Manager	James Mitchell, B.Sc. (Agric.) (Aberdeen).

Summary of Work.

The work of the Station consists of :—

(1) routine work arising from—

(*a*) the commercial control of seeds and plants which are peculiar to Scottish agriculture, especially the statutory control imposed by the Destructive Insects and Pests Acts, and the Seeds Act, and

(*b*) the comparison of new breeds of agricultural produce under the Board of Agriculture Scheme of registration of new varieties of agricultural products.

(2) Investigations arising out of (1) (*a*) and (*b*) above.

Seed Testing Station.

(1) *Routine.*—The routine work consists in the testing of approximately 9,000 samples of seeds annually ; in giving incidental advice on these samples, and in the development of seed-testing apparatus especially with a view to time saving.

(2) *Investigation Work.*—This is carried out as time permits and consists in analyses of samples of grasses and clovers in the growing state. The Station is specially concerned at present with investigations on methods of proving the authentic character of samples of wild white clover.

Registration Station.

(1) *Routine Work.*

(*a*) *Potatoes.*—New varieties of potato are tested for immunity from wart disease. Field trials are conducted of new varieties of potato offered for registration as distinct and improved varieties.

Observations are made on the behaviour of potato varieties with a view to obtaining information to predict probable market value of seedlings in the first five years of their existence, firstly as regards yield, secondly as regards diseases (particularly virus diseases). The observations are quantitative and qualitative, intensive and extensive.

(*b*) *Cereals.*—Field trials are carried out of new and selected varieties, and strains of cereals offered for registration.

(2) *Investigational Work.*

(*a*) *Potatoes.*—Immunity testing has been developed in the laboratory, during the winter months, on a scale equivalent to a

field scale. Experimental observations have been made on the validity of methods of field testing; and on the distinguishing characters of potato varieties for the practical purpose of maintaining pure stocks of varieties.

(*b*) *Cereals.*—Observations have been made on the distinguishing characters of oat varieties. Analyses have been made of cereal varieties, especially those which are peculiarly Scottish.

(3) *Projected Work. Virus diseases of the Potato.*

It is intended to investigate methods of determining the relative and absolute susceptibility of new varieties; to carry out investigations in brown spotting and necrosis of potato leaves; and to conduct experiments on the commercial practicability of building up virus-free or healthy stocks of varieties of the potato.

Facilities for Study and Research.

The Station is equipped to deal with :—

(1) Seed Testing.

(2) Field Testing of Cereals, Pasture Plants and Potatoes.

(1) *Seed Testing.*—Facilities can be provided for studying the technique of seed testing.

(2) *Field Certification of Crops.*—The work of comparative testing of new varieties of the potato, of training students for field inspection of potato crops and of improving the health of potato stocks, especially with reference to virus disease in general cultivation, is specially organised.

Work on the application in commerce of known facts concerning virus disease of the potato is in progress.

Part of the routine work of the laboratory has for its object the rapid determination of the susceptibility of potato seedlings to wart disease, 2,000–3,000 seedling varieties being handled annually.

Arrangements can be made for participation by overseas students in any part of this work.

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(12) SEED TESTING AND PLANT DISEASE DIVISION: MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

This Division is stationed at The Queen's University, Belfast.

Staff.

Head of Division	..	S. P. Mercer, B.Sc. (Agric.) (Lond.), N.D.A.
Chief Assistants :—		
Plant Diseases	..	A. E. Muskett, B.Sc. (Lond.), A.R.C.Sc.
Economic Botany	..	D. Clouston, M.A., B.Sc. (Edin.).
Assistant	.. ..	H. Cairns, B.Sc., B.Agr.

Summary of Work.

The chief problems under investigation in this Division are as follows :—

Plant Diseases.

I. *Potato Diseases.*

A study of Ordinary or Late Blight (*Phytophthora infestans*, de Bary) in Northern Ireland with particular attention to the following points :

(1) The most economical strength of Burgundy Mixture.
(2) The number of sprayings necessary to ensure the best results.
(3) The susceptibility or resistance to the disease shown by varieties lately introduced.
(4) Spraying *versus* dusting.
(5) The way in which the disease is carried over from season to season.

II. *Flax Diseases.*

Studies of the causal fungi, and methods of control. Seedling Blight (*Colletotrichum linicolum*, Pethy. & Laff.) and Browning or Stem Break (*Polyspora lini*, Laff.).

III. *Fruit Diseases and Pests.*

A. Apples.

1. *Frost Injury.*—An enquiry is in progress upon orchard heating as a preventive measure against damage to blossom by spring frosts.

2. *Apple Sucker and Greenfly.*—A series of comparative trials with tar distillate washes (applied in winter) to determine their relative efficiency in controlling these pests is almost complete.

3. *Apple Scab* (*Venturia inaequalis*, Aderh.).—During recent years scab has perhaps been the greatest obstacle to apple growing in Northern Ireland. Full investigations, both in the laboratory and in the field are being made with regard to this disease and its control. The following are some of the points under consideration :—

(*a*) The most suitable strength of Bordeaux Mixture.
(*b*) Bordeaux Mixture compared with Burgundy Mixture.
(*c*) The importance of early spraying.
(*d*) Varietal susceptibility to disease and to spray injury.

4. *Apple Capsid.*—Field experiments are in progress with regard to control measures for this pest, which has already become well established in County Armagh.

B. *Gooseberries.*

American Gooseberry Mildew (*Sphaerotheca mors-uvae*, Berk).—Very satisfactory results have been obtained from experiments relating to the control and a report has been published. Further experiments are in progress.

IV. *Forestry Diseases.*

A full investigation of methods to prevent the damping off of Sitka Spruce and Douglas Fir Seedlings caused by parasitic fungi has been tested with satisfactory results. A record of these is being prepared for publication.

V. *Celery Leaf Spot* (*Septoria apii* Bri. & Cav.).

An investigation concerning the prevention and control of this disease is in progress.

Seeds and Crops.

I. *Seeds.*

Seed production (chiefly from ryegrass) constitutes an important industry in Northern Ireland, the annual output being in the neighbourhood of thirty thousand tons. Problems affecting production and export are therefore of special moment. Investigations are in progress on the following lines :

(*a*) *Seed Growing.*—The effects of (i) Strain of seed, (ii) Manuring, (iii) Constitution of mixture sown, (iv) Maturity at harvest, (v) Methods of curing and (vi) Methods of storage form the subjects of separate experiments. Results so far accrued indicate that manuring does not usually affect quality of seed produced, or rate of maturing, but may influence keeping quality under poor storage conditions. Preliminary experiments upon date of cutting suggest that germination capacity of produce is not nearly so much affected by maturity at harvest as is usually supposed, but bushel weight may be seriously affected. On the other hand the quality of hay is obviously improved and probably that of ensuing pasture.

(*b*) *Shipping.*—Experiments with ryegrasses over five years show that loss of germination during shipment is not usually uniform throughout a parcel and appears to depend on the heat : moisture : time ratio of the voyage. Tropical passages seriously enhance the damage. Contents of bags may rise during shipment through Panama to a temperature of 33° C., with loss in germination ranging up to 20 per cent. Reduction of damage by ventilation and refrigeration is being attempted.

(*c*) *Seed Testing.*—Experiments are being pursued with regard chiefly to :

(i) *Lethal temperatures.*—In testing ryegrass by routine methods, the third day on the germinator seems to be the crucial period, and the critical temperature about 40° C.

(ii) *Sampling methods* in laboratory and warehouse. Preliminary results indicate that modification of current mixing and drawing methods is desirable. This investigation is under the ægis of the International Seed Testing Association.

(iii) *Effect of atmospheric conditions* upon accuracy of tests has been found much more pronounced in a damp climate than was supposed. In twenty-four hours, ryegrass exposed in a warm room may vary 3½ per cent. in weight and in a few days nearly 8 per cent. A short report on this point has been published.

II. *Crops.*

Biology of grasses—Alopecurus pratensis and *Lolium perenne* are subjects at present under observation. In the former the chief enemy to seed production in Britain seems to be the Gall Midge (*Oligotrophus Alopecuri*, Reut.) whose life history is being studied and methods of control contrived. *Lolium perenne* shows remarkable variation and some of its variants conspicuous longevity. Strains are being segregated. Preliminary reports have been published upon *Alopecurus.*

Extensive trials have been laid down to compare commercial strains of Wild White Clover.

Facilities for Study and Research.

See p. 24.

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(13) IMPERIAL BUREAU OF ENTOMOLOGY.

The Bureau, which was started in 1909 as the Entomological Research Committee (Tropical Africa), assumed its present form in 1913. Its objects were to serve as a central clearing-house for the collection and dissemination of information regarding injurious insects of all kinds, and to render any kind of assistance whatever to the Economic Entomologists of the Empire in connection with the practical or scientific aspects of their work. With the gradual growth of the organisation exigencies of space have led to its division into three sections.

Headquarters Office.

Thanks to the kindness of the Trustees of the British Museum the principal office of the Bureau is accommodated in the Natural History Museum, Cromwell Road, London, S.W.7, where the taxonomic specialists on the Bureau staff have been given special facilities for utilising the vast collections and libraries of the Museum.

Staff.

Director	G. A. K. Marshall, C.M.G., D.Sc., F.R.S.
Entomologists ..	G. E. Bryant, Dr. C. Ferrière, B. P. Uvarov, D. S. Wilkinson.
Abstractors	Mrs. Darling, Miss E. M. Ralfs, B.A.

This office is the centre of the general administrative and advisory work, as well as the identification of insects. The latter is a very important branch of the Bureau's work, and on an average some 55,000 specimens are received every year from 160 different correspondents, and the lists sent out involve some 7,000 specific identifications annually. In addition to valuable assistance received from specialists on the staff of the Museum, arrangements have also been made with many foreign specialists to help in the naming of insects.

PUBLICATION OFFICE.

This is situated in the premises of the Entomological Society of London at 41, Queen's Gate, London, S.W.7.

Staff.

Asst. Director and Editor ..	S. A. Neave, M.A., D.Sc.
Asst. Editors	H. S. Bushell, B.A., C. J. N. McCracken, B.A.
Abstractors	L. Nell, J. C. Robbins, Miss G. M. Jeans, Miss D. Wharton, Mrs. Baribaloff, Miss R. M. Davenport.
Librarian	C. J. Golledge.

In this office is carried out the preparation of the *Review of Applied Entomology*, a monthly journal containing abstracts of all papers dealing with injurious insects throughout the world, for which purpose over 1,000 periodicals and occasional publications are examined. The *Review* is divided into two sections: Series A, which deals with plant pests, and Series B, which deals with insects injurious to man and domestic animals. An average volume of this serial contains over 1,000 pages, comprising about 2,500 abstracts.

The Bureau also publishes an illustrated quarterly journal, the *Bulletin of Entomological Research*, containing original papers dealing with all aspects of Economic Entomology; this forms an annual volume of about 450 pages, with numerous plates and text-figures.

Again, the staff undertakes the compilation of the *Insecta* portion of the *Zoological Record*, an annual publication of about 420 pages, which contains a complete list of every book and paper published during the year on entomological matters, together with a condensed subject-index of their contents, and a list, in systematic order, of all the new species described.

The Publication Office contains a very fine library of publications dealing with Economic Entomology, comprising 6,000 bound volumes

and 12,000 pamphlets, all of which are available on loan. A subject-index of the contents of the library is in course of preparation

The Parasite Laboratory.

By means of a grant from the Empire Marketing Board, Farnham House, Farnham Royal, Bucks, was purchased in 1927 to serve as a field station. This is a 15-roomed house standing in 6½ acres of ground.

Staff.

Asst. Director and Superintendent ..	W. R. Thompson, Ph.D., D.Sc.
Entomologists	J. G. Myers, D.Sc., G. Salt, D.Sc., H. T. Rosenberg.

Scope of Work.

The principal object of the Laboratory is to further the control of the insect pests of agriculture and forestry by what has been called the biological method, that is, by means of beneficial parasites and predators. In the temperate portions of the Dominions and Colonies various European insects have been accidentally introduced without their natural enemies and have consequently in some cases developed into serious pests ; studies are therefore being made of these insects in their original habitats in order to discover the factors which there prevent their excessive increase, and the most efficient enemies are then sent out to the countries that require them.

Arrangements have now been made to start similar work in the Tropics, and Dr. J. G. Myers has been sent to the West Indies for two or three years for this purpose.

Arrangements have recently been made with the Australian Commonwealth Council for Scientific and Industrial Research for three of their Entomologists to carry out research at the Laboratory in connection with the control of various Australian insect pests and noxious weeds.

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(14) IMPERIAL BUREAU OF MYCOLOGY.

The Imperial Bureau of Mycology is situated at Kew in proximity to the Royal Botanic Gardens, the authorities of which have granted it special facilities of access to, and utilization of, their collections and library. It comprises laboratories in which accommodation is provided for a limited number of overseas workers, a museum of tropical plant diseases, a library which includes a large collection of pamphlets and reprints available for lending to mycologists in the Dominions and Colonies, and a publishing office for the *Review of Applied Mycology*. Its postal address is 17, The Green, Kew, Surrey, but arrangements are in progress for a new building to be erected near the Kew Herbarium.

Staff.

Director	E. J. Butler, C.I.E., D.Sc., M.B., F.R.S.
Assistant Director ..	S. P. Wiltshire, B.A., B.Sc.
Mycologist	S. F. Ashby, B.Sc.
Assistant Mycologist ..	E. W. Mason, M.A., M.Sc.
Abstractors	Miss K. Secker, V. Akimoff, A. A. Barge.

Aims of the Bureau.

The Bureau is intended to serve as a clearing-house for information on all matters concerning the diseases of plants caused by fungi, as a co-ordinating centre for work on these diseases carried out in the overseas parts of the Empire, and as a laboratory for the identification and study of the organisms responsible for plant diseases, especially in the tropics.

Summary of Work.

This may be divided into two main branches : the accumulation and rendering available of information regarding phytopathological and applied mycological work in all parts of the world, and the identification and study of fungous and bacterial plant pathogens. The abstractors summarize the papers published in some 500 journals and occasional publications, the abstracts being issued more promptly and in greater detail than is customary in abstracting periodicals, chiefly in order to meet the requirements of workers with poor library facilities, as in many of the Colonies. The *Review of Applied Mycology* consists entirely of these abstracts, and the 12 monthly parts and detailed subject index make up an annual volume of nearly 900 pages, containing about 1,500 separate notices. In addition to the published abstracts, detailed translations of important papers in the more difficult languages are made on request. Many of the papers noticed in the *Review*, and much of the older literature, is available for borrowing from the lending library, which contains some 10,000 items. The Bureau also aids in hunting up the relevant literature on particular problems and lending the original papers or supplying summaries of them. Copies of sections of the host index of over 40,000 cards, giving references to the fungi recorded on the major plantation crops, have been supplied to several of the Dominions and Colonies. The Bureau is also frequently called on to furnish information, or to put enquirers in touch with specialists in a position to give information, regarding current work in various phytopathological matters, to advise on sprays and fungicides for testing, and to assist in the framing of legislative regulations against the introduction of dangerous plant diseases into the different parts of the Empire.

Specimens and cultures of fungous and bacterial plant pathogens are received from all parts of the Empire for identification. Where possible, the organisms are studied in culture, and comparative cultural investigations of several of the more difficult genera of fungi responsible for plant diseases in the Tropics have been carried

out. Collections of fungi, mainly parasitic, are frequently sent in for naming. The Bureau aims at assisting in the preparation of reasonably complete plant disease surveys in the different parts of the Empire and also in the compilation of fungus floras, the absence of which in many areas is a serious defect. Overseas mycologists frequently require assistance in obtaining specimens and cultures of fungi required for comparative study in the course of their work. In the systematic work the co-operation of British and foreign specialists is sought, as it would be impossible for the small staff of the Bureau to deal adequately with all the enquiries that come in. In some cases help has been given to departments of agriculture in determining the cause of wastage of fruits in transit due to fruit-rotting fungi.

Arrangements have been made which enable members of the staff to visit the Colonies when required to advise on outbreaks of plant diseases.

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(15) PLANT PATHOLOGICAL LABORATORY: MINISTRY OF AGRICULTURE AND FISHERIES.

This Laboratory is not a Research Station in the ordinarily accepted sense, but is a branch of the Ministry itself, and is situated at Milton Road, Harpenden, Herts.

Staff.

Director	..	J. C. F. Fryer, M.A. (Entomologist).
Asst.-Director	..	G. H. Pethybridge, M.A., B.Sc., Ph.D. (Mycologist).
Assistants	..	A. S. Buckhurst, A.R.C.S., D.I.C., C. T. Gimingham, B.Sc., F.I.C., W. C. Moore, M.A., and A. Smith, B.Sc., M.A., Ph.D.

In addition to providing a scientific basis for the administration of the Destructive Insects and Pests Acts, and other functions, this Laboratory serves as a general centre for England and Wales for the diagnosis of and information concerning the diseases and pests of agricultural, horticultural and other crops, large numbers of specimens being received every year from all parts of the country.

Illustrated leaflets and articles dealing with the principal plant diseases and pests and their control are prepared for general use and are revised as and when necessary. A "Monthly Summary" showing the incidence of pests and plant diseases in England and Wales is prepared at the Laboratory and circulated in neostyled form, whilst printed Annual Reports dealing with these pests and diseases are also issued.

The Laboratory also acts as a co-ordinating centre for co-operative experiments on the control of pests and diseases carried on by the Advisers in Entomology and Mycology attached to the provincial centres.

B.—Horticulture.

(16) LONG ASHTON FRUIT RESEARCH STATION: UNIVERSITY OF BRISTOL.

Situation.—Long Ashton, nr. Bristol.

Railway Stations.—Temple Meads Station (L.M.S. and G.W.R. Joint), Bristol, 4 miles. The Research Station is within easy reach of this station by tramcar from Temple Meads to Tramway Centre (1d. fare), thence by 'bus to the Research Station, Long Ashton (5d. fare).

Flax Bourton Station, G.W.R., 1 mile. Local train service only. Occasional 'buses pass Station to Research Institute.

Telephone: Long Ashton 15.

Staff.

Director	Prof. B. T. P. Barker, M.A. (Cantab.).
Deputy Director ..	T. Wallace, M.C., M.Sc. (Dunelm), A.I.C.
General Chemistry ..	T. Wallace, M.C., M.Sc. (Dunelm), A.I.C. J. O. Jones, M.Sc. (Wales).
Bio-Chemistry ..	F. Tutin, M.Sc. (Bristol). V. L. S. Charley, B.Sc. (Hons.) (Bristol).
Entomology ..	C. L. Walton, M.Sc., Ph.D. (Wales). L. N. Staniland, A.R.C.S., D.I.C., *Advisory Officer.*
Mycology	R. W. Marsh, M.A. (Cantab.). L. Ogilvie, M.A., B.Sc. (Aberdeen), M.Sc. (Cantab.), *Advisory Officer.*
Plant Physiology ..	T. Swarbrick, M.Sc., Ph.D. (Leeds). J. C. Hinton, Ph.D. (Leeds).
Pomology	G. T. Spinks, M.A. (Cantab.). J. G. Maynard, M.A., Dip. Hort. (Cantab.), *Plantations Officer.*
Cider	O. Grove, M.Sc. (Bristol).
Willows	H. P. Hutchinson, B.Sc. (Lond.).

Aims of the Station.

The work of the Station has as its object the investigation of problems relating to (*a*) Fruit culture, (*b*) Diseases of horticultural crops—more especially of fruit crops, (*c*) Fruit preservation and products—including cider making and ordinary and cold storage of fruits, (*d*) Willow cultivation and the utilisation of osiers in rural industries.

The Station also functions as an advisory centre for problems relating to these subjects.

In accordance with the aims of the Station the problems under investigation may be grouped conveniently under the headings (*a*) Fruit culture, (*b*) Pests and diseases and their control, (*c*) Fruit

preservation and products, (*d*) Willow culture and the utilisation of willows. The Station is well equipped for these various lines of investigation. There are laboratories fitted for all branches of the work, greenhouse accommodation is available for indoor experiments with plants, and facilities are provided for pot culture work. There is also a cider factory equipped with modern appliances for cider making, and cold and ordinary temperature fruit stores.

Adjoining the buildings is the farm, embracing some 257 acres, of which about one-half is suitable for experimental work on fruit. At the present time approximately 100 acres are occupied with experimental fruit plots.

A willow bed has been established, in which over 200 varieties are being grown for the purposes of investigation and demonstration.

Summary of Work.

The main problems under investigation at the present time are as follows :—

I. *Fruit Culture.*

(i) *Investigations on Tree Fruits.*

The largest section of the work under this head relates to the numerous problems which arise in connection with the nutrition of fruit trees. In this section of the work are included (*a*) root stock problems, (*b*) factors determining the relation of growth and fruit bud formation, (*c*) manurial experiments, (*d*) functional diseases due to defective nutrition, (*e*) the action of rain on foliage.

(*a*) In the work on root stocks attention is being given to the so-called " free " and " crab " stocks of the apple. In connection with the former a series of stocks capable of propagation by layering methods has been selected with the object of finding stocks of sufficient vigour to serve for the raising of standard trees for orchard purposes and at the same time to be suited for multiplication vegetatively so that the present want of uniformity due to the use of seedling stocks of varying vigour can be avoided.

(*b*) The investigations under (*b*) are very varied. The more important deal with the relationships between (i) stock and scion and (ii) the root and shoot growth ; the character and movement of food reserves in relation to growth ; fruiting and disease resistance ; the response to pruning methods.

(*c*) Problems of the manuring of fruit trees are attacked by laboratory, pot culture and field methods. The field experiments are not confined to the Station plots, many being carried out in commercial plantations where definite problems exist.

(*d*) Of the functional disorders leaf scorch and chlorosis have so far received special attention and the investigations on the former have reached an advanced stage.

Closely related to the above investigations on nutrition is the survey work on the soils of fruit-growing areas which is in progress. These surveys are designed to establish the relationships which exist between various soil conditions and the growth of fruit trees. The results so far obtained indicate the great importance of this line of work to the fruit grower on account of the help afforded in the selection of soils suited to fruit culture.

(ii) *Investigations on Soft Fruits.*

Considerable attention is given to problems relating to the various soft fruits—strawberries, raspberries and loganberries, black currants, red currants and gooseberries.

Strawberries.—In the case of strawberries an exceedingly comprehensive programme of work is in course of progress. Investigations on a large scale on this fruit have been undertaken in view of the serious condition which exists in the industry to-day, which appears to be mainly due to the widespread occurrence of a devastating deterioration in the quality of the plants, the causes of which have hitherto been undetermined.

The programme includes the study of the life cycle of the strawberry plant, problems of varieties, strains, propagation methods, cultural methods, nutrition, diseases and abnormal plant forms. Considerable progress has been made along certain of the lines of work and in the immediate future attention will be devoted mainly to the study of the diseased forms associated with the more serious commercial failures.

Raspberries.—The main feature of the work on raspberries is the carrying out of a scheme of variety trials in conjunction with the East Malling station. Pure lines of these varieties have now been established as the result of preliminary systematic selection.

Currants.—Work is proceeding on the identification and classification of red currant varieties, about which relatively little is known at present.

In the case of black currants the study of problems relating to the propagation from cuttings is in progress.

Gooseberries.—The work on gooseberries is also chiefly concerned with the sorting out of pure lines of the varieties and the problems of variety classification.

(iii) *Fruit Breeding.*

Fruit breeding takes an important place in the Station programme and several acres of the plantations are occupied by seedlings of tree and bush fruits bred at the Station. The work is chiefly confined to apples, plums, pears, black currants, various Rubi and strawberries.

The work on black currants has reached a fairly advanced stage and several promising selections have been propagated on a fairly

large scale, whilst with apples and plums the individual seedlings have now reached the cropping stage.

II. *Pests and Diseases of Fruit and their Control.*

In this branch of the Station's activities it is necessary for the workers concerned to give general attention to pests and diseases which from time to time inflict serious damage in the fruit plantations of this country. There are, however, certain pests and diseases and certain problems relating to spray fluids and other forms of disease control which form the subjects of special study by the pathological staff, and the more important of these are mentioned here.

(i) *Entomological.*

In the entomological department the two important diseases of the black currant—" reversion " disease and " big bud " disease—have been the subjects of elaborate investigations and this work, which is still proceeding, has led to important practical findings.

Other subjects under investigation in this department are Red Plant disease of strawberries ; Strawberry Aphis ; control of Capsid Bugs, Pear Midge and Willow pests ; and the relation between manurial treatment and susceptibility to insect attack.

A considerable amount of work—both entomological and chemical —has been carried out on tar distillate washes, which were first introduced into this country by the Station and are now largely used as winter washes to kill the eggs of certain destructive insect pests such as apple and plum aphides.

The possibility of utilising certain miscible oils as sprays for spring and summer use is being examined.

(ii) *Mycological.*

The main mycological investigations relate to " Die-back " in fruit trees, collar rots of fruit trees—especially *Rosellinia necatrix*, strawberry diseases, crown rots of the raspberry, the control of American gooseberry mildew, and the fungicidal action of sulphur.

In connection with " Die-back " diseases a 5-acre plantation of plum varieties on several different forms of root stocks has been established on the Station grounds.

The work on sulphur forms a very comprehensive study in which the mechanism of the action of this substance in relation to the fungus and the host plant is being examined in detail.

III. *Fruit Preservation and Products.*

Under this section are included cider-making investigations, which are a prominent and unique feature of the work of the Institute ; cold storage work on fruits, which is carried on in conjunction with the Food Investigation Board ; and chemical studies on the

composition of fruits. A comprehensive investigation relating to the effects of cultural and other conditions during the growing of fruits on the ultimate qualities of the fruits is being carried out under a grant from the Empire Marketing Board. Much attention has been given to pectin, a constituent of the apple and other fruits, which is of fundamental importance in the jam-making industry.

The field covered in cider investigations is very comprehensive, the programme including a whole range of problems which arise in the production of suitable raw material and in the manufacture of the beverage.

Special attention is at present directed to problems relating to the action of sulphur dioxide as a preservative on apple juice and cider, the utilisation of ungradable culinary and dessert apples in the cider industry, and the production of ciders of uniform character and free from liability to bacterial disorders by the preliminary pasteurisation of the freshly expressed juice and subsequent fermentation with pure cultures of selected yeasts.

IV. *Willow Culture and the Utilisation of Willows.*

The programme of work on willows is designed to supply information on any problems which may arise in connection with the growing, marketing and utilisation of willows. It includes investigations on varieties, propagation of sets, cultural treatments, harvesting and preparation of rods for market, control of pests and diseases, and uses of willow products.

Facilities for Study and Research.

At this Station, which is attached to the University of Bristol, research is in progress on the following subjects : fruit culture, fruit storage, fruit products, cider-making, fermentation, microbiology, diseases of plants (particularly of fruit trees and fruit) and their control, insecticides and fungicides, willow culture and the utilisation of willows. At the associated Research Station at Chipping Campden the main subject of research is the preservation of fruits and vegetables, including canning.

Facilities for study and research in the laboratory are supplemented by those provided in the fruit and willow plantations, the cider house and the canning and preservation factory attached to the respective Stations, in which the operations of fruit and willow culture, cider-making and fruit and vegetable preservation are carried out on a practical scale.

Opportunities are available to research workers to qualify for research degrees in Science (B.Sc., M.Sc., Ph.D., and D.Sc.). Candidates must be accepted as recognised students in the University of Bristol. The necessary conditions are indicated in the Ordinances, a copy of which is obtainable from the Station at Long Ashton. The Stations are also open to post-graduate workers not desiring to

qualify for a degree, in which case entry as recognised students in the University is unnecessary.

Intending workers should apply in the first instance in either case to the Director, stating the subject of work proposed and the probable length of stay.

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(17) FRUIT AND VEGETABLE PRESERVATION RESEARCH STATION: UNIVERSITY OF BRISTOL.

This Station is situated at Campden in Gloucestershire.

Railway Station.—Campden—Great Western Railway.

Telephone.—Campden 9.

Staff.

Acting Resident Director and Micro-Biologist	F. Hirst, M.Sc., A.R.C.S.
Assistant Chemist	W. B. Adam, M.A., A.I.C.
Demonstrator in Food Preservation	Margaret L. Adams.

Aims of the Station.

Climate and the incidence of disease make a nice adjustment of supplies of fresh fruit to the demand impossible. Considerable fluctuation in yield is incidental to fruit and vegetable culture, and the necessity for developing fresh outlets for produce has been emphasised especially in recent years. The demand for fruit and vegetables out of season has become thoroughly established, and various forms of preserved fruits have become common articles of food. Moreover, improved methods of marketing involving the grading of produce have brought the growers face to face with the problem of the profitable disposal of the low-grade material, which at present constitutes a relatively large proportion of the crop.

For these reasons the industries associated with fruit and vegetable preservation and products are capable of making a substantial contribution to the prosperity of growers by affording important outlets for produce.

Fruit production in the British Empire is under a very heavy handicap as compared, for instance, with the United States, where the preservation and products industries have been developed on an enormous scale. The Empire—and especially Great Britain—is importing immense quantities of canned and other forms of preserved fruit and vegetables from foreign countries.

The Campden Research Station has been established to carry out research and experimental work on fruit and vegetable preservation and products, and serves as the centre for educational and advisory work on this subject.

Summary of Work.

The scope and character of the work being carried out at present are as follows :—

Research.

1. Canning of fruit and vegetables with special reference to :

(*a*) Commercial scale trials of soft fruits to determine the best temperatures and times of processing in relation to different sizes of containers, the preservation of colour, and the use of syrups. These experiments are being carried out in conjunction with two canneries in Gloucestershire.

(*b*) The suitability of different varieties for canning : peas, raspberries, strawberries.

(*c*) The testing of lacquers for use on tinplate for fruit and vegetable containers, with a view to retaining the natural colour of red fruits when canned, and in the case of vegetables to prevent blackening of the cans. This work is being carried out in conjunction with Messrs. Williamson & Sons, Ltd., Worcester, canmakers, and Messrs. Holden & Sons, Ltd., Birmingham, lacquer manufacturers.

(*d*) The retention of the green colour in canned peas, beans, and spinach.

2. Experiments on the use of sulphur dioxide as an antiseptic in conjunction with various methods of preservation.

3. The preparation and use of fruit juices and syrups.

4. Jam and jelly making at relatively low temperatures, and the use of fruit pectins for fruit preserves.

5. Experiments on the preparation of plum products.

6. Investigations on the bio-chemistry of the " brining " process for the preparation of vegetables for pickling.

7. Packing fresh fruit in cans.

8. Waste products : utilisation of mushroom stalks, apple peels and cores.

Education.

1. Five courses of instruction in fruit and vegetable preservation are given annually, each lasting ten days.

2. Extra-mural lectures to Women's Institutes and Young Farmers' Clubs are given during the fruit season.

3. Leaflets on the preservation of gooseberries, raspberries and loganberries, currants, cherries, blackberries, plums and damsons, pears, tomatoes, apples, vegetables, and on the preparation of marmalade, chutney, crystallised and glacé fruits, have been published for use by the general public.

Advisory.

The Station undertakes investigations, and furnishes reports on canning and other preservation problems to firms engaged in the preserving industries, and gives technical assistance to the National Food Canning Council.

Facilities for Study and Research.

See p. 55.

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(18) HORTICULTURAL RESEARCH STATION, EAST MALLING, KENT.

Nearest Station.—East Malling Halt—Southern Railway. Or from Maidstone (5 miles) to East Malling Church by 'bus every half hour. *Telephone :* Aylesford 29.

Staff.

Director	Ronald G. Hatton, M.A.
Assistant Director ..	R. C. Knight, D.Sc., D.I.C., of Imperial College of Science and Technology Staff.
Pomology	R. G. Hatton, M.A. N. H. Grubb, M.S.A. W. S. Rogers, B.A.
Statistics	T. N. Hoblyn. (Hort. Dip. Wye).
Plant Physiology ..	R. C. Knight, D.Sc., D.I.C. M. C. Vyvyan, M.A. (Cantab.).
Bio-Chemistry	W. A. Roach, B.Sc., A.R.C.Sc., D.I.C.
Pathology	H. Wormald, D.Sc., A.R.C.Sc., D.I.C. R. V. Harris, B.Sc., A.R.C.Sc.
Entomology	A. M. Massee, F.E.S.

Summary of Work.

The principal subjects under investigation at East Malling may be classified under :—

I. *Researches on Fruit Plants.*

(*a*) Pomology.

(*b*) Physiology.

(*c*) Pathology :

(i) Mycological.

(ii) Entomological.

II. *Hop Investigations.*

I. *Researches on Fruit Plants :*

The main lines of work already under investigation and likely to be continued for some years are as follows :—

(*a*) *Pomology.*—Activities under this heading include systematic cultural and breeding work. The confusion existing with regard to the naming of horticultural varieties has necessitated preliminary work in identification, selection, description and the raising of pure lines. Such work has already been undertaken both in the cases of the root stocks upon which fruit trees are grafted, and also with black currants and raspberries. The suitabilities of the different varieties for market purposes are also being studied. New varieties are being raised.

Upon the cultural side East Malling has set itself to study the effects of various operations upon the plant's individuality. A study of the " build up " of the tree is in progress, and the effects of budding and grafting, of intermediate grafting and of the selection of both root stock and scion are being followed out. This work involves a special study of methods of vegetative propagation and subsequent selection and breeding of desirable types of root stock. Standardisation of the fruitgrower's material, by reducing the variability of fruit plants, is the economic object in view.

The modifications effected by various soils and by different methods of treatment upon the individual are next being followed up. For instance, different methods of planting, manuring, and pruning are being studied in relation to the tree as a whole and to particular varieties. The effects of spray fluids upon the tree, apart from their fungicidal or insecticidal value, are being traced.

The cultural programme has as its object the establishment of the best possible plant under the best growing conditions.

(*b*) *Physiology.*—A systematic physiological study of the relations between stock and scion is in progress with the double aim of elucidating the mechanism of stock influence, and of characterising stocks from their physiological reactions. Analysis of stock and scion relations is also being attempted in a series of field experiments.

The principles underlying vegetative propagation are being investigated in order to discover methods of multiplying desirable varieties of stocks which are difficult to raise.

The inter-relation of shoot and root growth of fruit plants is being studied, especially in connection with pruning and propagation.

(*c*) *Pathology.*—The investigations relate to certain fungal, bacterial and virus diseases and insect pests. One of the most striking manifestations of the plant's individuality is its susceptibility or resistance to disease and its response to remedial measures. The true lines of plants established at East Malling are being used for such studies, both by the Mycological and Entomological sections.

Different varieties of root stocks and soft fruits show varying degrees of susceptibility to diseases and pests. The susceptibility of apple stocks to the permanent apple aphis, the woolly aphis, and crown gall, and of certain selected cherry stocks to cherry aphis is under especial study.

Resistant plants are being selected or bred and vegetatively propagated for further trial. The effect of different plum stocks upon the incidence on the trees of silver leaf disease, and possible preventive and control measures for that disease in the field, are being worked out.

The possible reaction of different root stocks upon the scions grafted thereon is also being carefully observed in the case of apple mildew, canker and scab. A special study is being made of the susceptibility of raspberry varieties to particular diseases.

Particular attention is also being paid by the Mycological Section to :—

(1) Bacterial Canker of Plum and Cherry Trees.
(2) The distribution and control of the Brown Rot Diseases.
(3) Diseases of Raspberries.
(4) The control of Apple Scab and Mildew.

The Entomological Section is also specializing upon :—

(1) The Gall Mites, many of which, especially on the small fruits, are of great importance to the fruit grower.
(2) The control of the Apple Sawfly.
(3) The testing of certain egg-killing washes.
(4) The relation of certain insects on raspberries and the transmission of virus diseases.
(5) So-called Reversion and its possible transmission by a new species of Mite.

II. *Hop Investigations.*

East Malling is growing and drying for chemical analysis and brewing trials leading commercial varieties of hops and a number of new seedlings bred and selected by Professor E. S. Salmon (Wye). Data are being collected as to the weight, ultimate yield, resin contents and market value, as well as disease resistance, of these varieties.

Manurial trials, designed to test not only the effect upon the yield, but also upon the quality of the hops, are also in progress.

Cultural experiments in methods of "cutting," "pulling," &c., have been initiated.

Systematic descriptions are being made of the principal commercial varieties of hop with a view to establishing easy methods of identification and as a preparatory to ultimate selection of good strains. Various diseases of the hop plant are under investigation.

Facilities for Advanced Study and Research.

In close conjunction with the pomological and statistical investigations in the field, pathological (including mycological, bacteriological and entomological), physiological and bio-chemical problems are being studied through the medium of horticulture by some twelve permanent scientific workers.

From time to time it has been possible to associate selected post-graduate workers with particular aspects of these investigations, in which the resident research staff are engaged, both in the laboratories and in the field.

Such post-graduates, who have guaranteed a minimum term of residence, have attended the regular staff discussions on research problems, and been given facilities for studying the general organization and experimental technique employed.

Owing to limitations of space, equipment and special organization, the number of voluntary workers thus received at any one time has been very restricted, but a scheme is at present under discussion for increasing facilities to meet the growing demand of horticultural investigators.

No fees have or would be charged to such voluntary workers, though a contribution towards the materials, apparatus, &c., used is expected.

Workers desiring to be admitted should communicate with the Director, giving full details of their qualifications and the subject with which they wish to be associated.

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(19) HORTICULTURAL RESEARCH STATION: CAMBRIDGE UNIVERSITY.

The orchard and experimental grounds of this research station are situated on the University Farm, Huntingdon Road, Cambridge. The nearest railway station is Cambridge. The laboratory is at the School of Agriculture, Downing Street, Cambridge. The Station is under the general control of the Director of the Plant Breeding Institute and a committee representative of fruit and vegetable growers. *Telephone:* Cambridge 569.

Staff.

Director	.. Prof. Sir R. H. Biffen, M.A., F.R.S.
Deputy Director ..	.. D. Boyes, M.A.
Physicist	.. R. M. Woodman, Ph.D.

Summary of Work.

The chief subjects of investigation in progress at present are, amongst fruits, the breeding of improved varieties of apples, pears, plums and strawberries, and amongst vegetables, onions, various brassicae and parsnips. Pruning trials are also being made of a number of well-known varieties of apples on various East Malling stocks, and a series of pears is being grown to test their value for commercial cultivation. A comprehensive series of investigations on the physics of spraying fluids is in progress with the object of securing better wetting and adhesive properties in fungicides and insecticides and more lasting emulsions of various oils used in the control of plant diseases.

Facilities for Advanced Study and Research.

Facilities are available for genetical work on the majority of market garden crops and also on fundamental problems associated with the preparation of fungicides and insecticides.

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(20) EXPERIMENTAL AND RESEARCH STATION: CHESHUNT.

This institute is situated at Turner's Hill, Cheshunt, Herts, in the centre of the Lea Valley Glasshouse district. The nearest railway stations are Cheshunt (12 minutes walk) and Waltham Cross ('bus outside station going to Cheshunt passes the door), both on the L.N.E. Railway from Liverpool Street Station, London. *Telephone:* Waltham Cross 150.

Staff.

Director	.. W. F. Bewley, D.Sc.
Entomology ..	.. E. R. Speyer, M.A.
Chemistry	.. O. Owen, Ph.D., M.Sc., A.I.C.
Mycology	.. P. H. Williams, B.Sc.

Aim of the Station.

The object of the Station is to investigate the many problems which arise during the commercial cultivation of glasshouse crops. Advisory work is an important feature.

Summary of Work.

I. *Manurial and crop management trials with tomatoes and cucumbers.*

These are conducted in the experimental glasshouses of the Station, which are constructed on commercial lines. All records are

designed to determine the effect of the different treatments upon weight of crop, quality of fruit and resistance to diseases and pests.

The current experiments are arranged to test the following :—

(*a*) *Tomatoes.*

(1) The effect of different methods of watering (*a*) through underground pipes, (*b*) through twelve inch pots sunk in the ground, (*c*) by means of trenches, (*d*) by a hose in the usual manner.

(2) The effect of " stopping " at the fifth truss in comparison with " running on."

(3) The effect of increasing quantities of nitrogen, potash and phosphate ; the object being to discover the correct proportion of these nutrients in a good tomato fertiliser mixture.

(4) The effect of green manuring and fallowing under glass.

(5) Variety trials are also included.

(*b*) *Cucumbers.*

(1) Past experience has shewn that failure of the cucumber crop is mainly due to the presence of harmful influences in the base, or soil upon which the beds are placed. The experiments are designed to test different methods of treating the base to remove these factors. The present treatments are mainly concerned with steam sterilisation.

(2) The effect of incorporating such opening material as hedge clippings, straw and bean straw in the beds.

II. *Animal pests of glasshouses.*

(*a*) *Red Spider Mite.*—This serious pest of glasshouse plants has been studied during the past five years. Control measures under investigation are as follows :—

(1) Fumigation of the houses with naphthalene as soon as the crop is finished.

(2) Washing down with cresylic acid emulsion.

(3) Spraying the growing crop with emulsified petroleums.

A special investigator is making observations on commercial nurseries with a view to preventing attacks by improved methods of hygiene and crop management.

The services of a special chemist are being employed for the study of the action of gases and vapours upon the pest.

(*b*) *White-fly.*—A Chalcid parasite of white-fly has been successfully reared through the winter, so that a stock of considerable magnitude is available for experimental control by this means. Large numbers of parasites have been distributed to nurserymen with promising results.

III. *Diseases of glasshouse plants.*

The following are under investigation :—

Mosaic disease of cucumbers and tomatoes.
Tomato Mildew (*Cladosporium fulvum*).
The *Diplodina* disease of the strawberry under glass.
" Damping-off " of the cucumber.
Cucumber root-rot.
" Black spot " of the rose.

IV.

Investigations are in progress to determine the effect of temperature and light on the cucumber and tomato under glass. This includes (1) the use of glass which transmits more of the ultra-violet rays than ordinary horticultural glass and (2) the heating of the soil by means of electrically heated wires.

V. *Chemical Investigations.*

(*a*) An attempt is being made to determine the effect of manurial treatment on the availability of nitrogen in tomato soils. For this purpose, soil samples are taken, weekly, from various experimental plots in both the new and the old houses. These samples are analysed immediately for moisture, nitrates and ammonia.

(*b*) A type of tomato injury has been traced to the presence of chlorates in the soil, and an attempt is being made to determine their origin.

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(21) JOHN INNES HORTICULTURAL INSTITUTION.

Address.—The John Innes Horticultural Institution, Mostyn Road, Merton, S.W. 19. *Telephone :* Wimbledon 3645.

The laboratories and experimental grounds of about 14½ acres are situated at Merton, Surrey (railway station, Wimbledon).

The John Innes Horticultural Institution was founded in 1910, and derives its income from a Trust fund created by the will of the late John Innes. It is administered under a scheme of the Charity Commissioners by a representative Council appointed by the Royal Society, the Ministry of Agriculture, the Linnean Society and the Royal Horticultural Society and the Fruiterers' Company. The first Director was the late William Bateson, who died in 1926.

Staff.

Director	Sir Daniel Hall, K.C.B., F.R.S.
Plant Breeding and Genetics ..	J. B. S. Haldane, Dr. E. J. Collins, the Misses C. Pellew, D. de Winton, and J. Andersson, Mr. Philp, Dr. F. W. Sansome.

Cytology	Drs. C. D. Darlington and C. L. Huskins, Miss A. E. Gairdner.
Mycology	Miss D. M. Cayley.
Fruit Problems	M. B. Crane, W. J. C. Lawrence.
Physiology	*The Director* and Dr. E. Phillis.
Education	H. D. Bennett.

Summary of Work.

The main line of work at the Institution is the study of the genetics and cytology of cultivated plants. At present work is in progress on species of *Primula, Campanula, Antirrhinum, Dianthus, Pisum, Dahlia, Avena, Triticum, Linum, Scolopendrium, Tulipa,* &c., &c., Other lines of work are :—chimeras and graft hybrids, sterility in and fertilisation of cherries, plums and apples, the inheritance of disease resistance, the reserve materials of the tulip, &c., &c.

The Institution is open to receive voluntary research workers.

The Institution appoints annually a certain number of Exhibitioners, young working gardeners, who receive a course of scientific instruction and technical training, while assisting in the routine work of the Institution.

In July, 1928, the Institution held a short course of instruction in genetics and cytology, with practical work, for senior students recommended by a Professor of Botany.

C.—Animal Pathology.

(22) RESEARCH INSTITUTE IN ANIMAL PATHOLOGY: ROYAL VETERINARY COLLEGE, LONDON.

The Institute occupies a site close to that of the Royal Veterinary College, in Great College Street, Camden Town, a short distance from St. Pancras Town Hall. The nearest railway station is Mornington Crescent on the Hampstead Tube Railway. Its distance from St. Pancras and King's Cross Stations is about half a mile. *Telephone :* North 4312.

Staff.

Director of Research ..	F. C. Minett, D.Sc., M.R.C.V.S.
Senior Assistants ..	A. D. McEwen, B.Sc., M.R.C.V.S.
	A. W. Stableforth, B.Sc., M.R.C.V.S., D.V.S.M.
Assistants	S. J. Edwards, B.Sc., M.R.C.V.S.
	One vacancy.

Aims of the Institute.

The function of the Institute is to endeavour to extend knowledge regarding the diseases of the domesticated animals, especially in the direction of causation and prevention. The Institute is in close touch throughout the country with veterinary surgeons and stockowners, and the diseases from time to time selected for investigation are those that appear to be of the greatest importance from an economic point of view. Those that have been the subject of most prolonged research are abortion in cows and mares, arthritis in foals, Johne's disease, mastitis in cows, parasitic gastritis in ruminants, and quarter-evil in cattle.

Summary of Work.

Epizootic Abortion in Cows.—The work in connection with this disease was a continuation of that carried out under the Committee appointed by the Board of Agriculture in 1905, and in the first place it was directed to exploring the value of the agglutination test for the diagnosis of the disease. Through the agency of the Royal Agricultural Society and practising veterinary surgeons the Institute was placed in connection with owners of infected herds who were willing to have the whole of their breeding animals tested.

As soon as experience had proved the accuracy of the test attempts were made in various infected herds to eradicate the disease by carrying out repeated tests and isolating the animals thus found to be infected. It was soon found that this method was liable to failure when an attempt was made to isolate the infected animals on the same premises as the healthy. It was shown, however, that even badly infected herds could quickly be freed from the disease when the affected animals could be removed to premises at some considerable distance from those in which the healthy portion of the herd remained.

Other important facts that emerged from the researches were :—

(1) That although young cattle can readily be infected with the disease those under breeding age usually make a complete natural recovery :

(2) That in breeding animals on the contrary a speedy recovery is quite exceptional, many cows remaining infected for years and presumably remaining capable of spreading the disease.

The observations made in infected herds showed that in many cases from 30 to 50 per cent. of the cows were infected. Tests also showed that a small proportion of bulls were infected, but observations made in infected herds did not indicate that the bull played a part of any importance in the infection of the cows. Research on certain aspects of the problem is being continued.

Abortion in Mares.—Any form of contagious abortion in mares appears to be comparatively rare except in thoroughbred studs, and the researches of the Institute have shown that the most frequent

cause is the Bacillus abortivo-equinus, but in a few cases streptococci or coliform bacilli have been found. It is believed that killed cultures of the causal bacilli might be used without danger to confer immunity on mares.

Joint-ill in Foals.—The researches with regard to what is generally called joint-ill in foals have shown that the name covers a number of infections caused by distinct species of bacteria. All the information obtained indicates that about 60 per cent. of the cases are caused by streptococci, and that the disease is not contracted otherwise than by infection at the navel immediately after birth. Serum and vaccine treatment was tried in a number of cases but there was no evidence that the incidence of the arthritis or mortality among the foals was reduced.

Johne's Disease.—This disease has been studied particularly with regard to the cultural and other characters of the causal bacillus, the symptoms and duration of the disease, the appearance and histology of the lesions, the transmissibility of the disease, its natural occurrence in different species of animals, the period of incubation, and treatment.

Mastitis in Cows.—Past work has shown the importance of streptococci and of *Bacillus pyogenes* in connection with mastitis. An effort is now being made to define more clearly the bacterial types associated with the condition, with a view to devising an effective method of prophylactic vaccination.

Parasitic Gastritis in Ruminants.—The investigations have shown that it is the smaller species of nematode worms that are the principal cause of the disease in this country, the *Haemonchus contortus* being only exceptionally the cause of trouble. An extensive trial has been made of the drugs that have been in general use in the treatment of the disease, and not one of them has been found to be effectual in killing the smaller stomach worms (*Ostertagia circumcincta, Trichostrongylus extenuatus, Trichostrongylus instabilis,* and *Trichostrongylus vitrinus*).

Quarter Evil.—A vaccine has been prepared from cultures of *B. chauveaui* which in respect of safety and efficacy appears to be superior to any hitherto employed for immunising young cattle against the disease. A vaccine prepared from cultures of *vibrion septique* has also been shown in laboratory experiments to be effective against blackquarter-like conditions in sheep.

Facilities for Advanced Study and Research.

Visitors from overseas who desire to carry out research work relating to animal pathology or to complete work commenced elsewhere would be welcome. The present interests of the Institute are chiefly bacteriological and research is proceeding on bovine mastitis, bovine abortion and certain anaerobic infections of sheep.

Accommodation can be provided for two workers from overseas but special research grants would be required for the purchase of

experimental animals or expensive apparatus or if the work necessitated an increase in laboratory personnel.

Visitors who hold the necessary qualifications and are otherwise eligible and who are able to remain in London for a sufficient length of time may submit theses based on their researches for the Fellowship Diploma of the Royal College of Veterinary Surgeons or for the M.Sc., Ph.D., or D.Sc. (Veterinary Science) of the University of London.

Candidates are advised to apply to the Director of the Institute if possible before February 15th of the year in which the work is to be started.

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(23) DEPARTMENT OF ANIMAL PATHOLOGY: CAMBRIDGE UNIVERSITY.

The offices and principal research laboratories of the Department of Animal Pathology form part of the School of Pathology in the University. The Field Station of the Department is an independent unit, occupying its own buildings and lands adjoining the original University Field Laboratories at Milton Road (the Cambridge —Ely main road). The distances from the town railway station and from the Market Place are some 3½ miles and 2 miles respectively. *Telephone:* Cambridge, 806.

The Department was established in 1923, and a staff formed without delay, but work had to be carried out in temporary quarters at the Field Laboratories and at the Medical Schools until the completion of the Department's Field Station in the summer of 1926, enabled the Staff to occupy their own quarters.

The offices and principal laboratories in the School of Pathology have recently been completed, and the Department is now in occupation of these premises. It is anticipated that by centralising the two branches of pathology collaboration will be facilitated and the value of the comparative study of disease will be materially increased.

Staff.

Director	Professor J. B. Buxton, M.A., F.R.C.V.S., D.V.H., Professor of Animal Pathology at Cambridge University.
Assistant Director ..	T. J. Bosworth, B.Sc., M.R.C.V.S., D.V.S.M.
Pathologists	R. E. Glover, B.Sc., M.R.C.V.S. J. R. M. Innes, M.R.C.V.S. H. R. Allen, M.R.C.V.S. W. A. Wood, M.A., M.R.C.V.S. A. C. Fraser, B.V.Sc., M.R.C.V.S. L. Jordan, M.R.C.V.S.
Chemists	J. Stewart, M.A., B.Sc. G. D. Shearer, B.Sc.
Physiologist	C. W. Bellerby, M.A.

Aims of the Institute.

The work of this Institute consists almost entirely of investigations into the diseases of farm animals. In order that this may be effected as economically as possible, liaison is maintained with veterinary practitioners, agricultural organisers and stockowners. In addition a department has been created which deals entirely with the routine diagnosis of pathological material sent in by veterinary surgeons and stockowners, while the agricultural organisers keep the Institute informed of serious outbreaks of disease amongst animals in their areas. This organisation has been found to be of very great value in preventing and controlling losses upon individual farms.

In order that investigations may be carried out upon premises at which an outbreak of disease exists, a motor laboratory has been specially built and equipped in such a way that while being capable of considerable speed and of mobility in difficult places, it provides all the facilities for prolonged field investigations. By this means such investigations can be carried out in a thorough manner in any part of the country. A special department—under expert supervision—also exists for the preparation of vaccines and other biological substances in large amounts for experimental purposes in the field.

While several senior members of the Staff are primarily engaged in special research, they are always available to form part of a team for any particular investigation.

Summary of Work.

Owing to the pressing demand for enquiry into a number of diseases of farm animals it has so far been found necessary to base the scheme of work upon the urgency of the need for these investigations, many of which are seasonal in occurrence, and not upon any definite or orderly programme. Special attention has been given to a variety of sheep diseases. Many of these occur at or about the time of lambing, which, in any one district is a relatively brief period for any investigation. It is therefore necessary to concentrate all the resources of the Institute upon these investigations during the short time which is available. It is also necessary to begin the work amongst the earliest lambing breeds in the South and to follow up the lambing time northwards until the Border Counties are reached in May. Such a procedure is only rendered possible by the motor laboratory and mobile section of the staff. As a result of this organisation it has been possible to undertake a number of investigations and to bring several to a successful conclusion in a very short space of time.

In detail, the work of the Institute is proceeding along the following lines :—

Cattle.

Tuberculin Tests.

Contagious Abortion—Research into more appropriate and satisfactory methods of control.

Sheep.

Contagious Abortion—further experiments in prevention.
Joint Ill in Lambs—preventive vaccination and treatment.
Mastitis in ewes—etiology and prevention.
Dysentery of Lambs—etiology and prevention.
Caseous Lymphadenitis—etiology and prevention.

Pigs.

Swine Erysipelas—field experiments in active immunisation.
Parasitic Diseases—prevention and treatment.
Nutritional Diseases.

General.

Routine diagnosis of specimens and advice regarding prevention or treatment.
Field investigations of large outbreaks of disease. Preparation of experimental vaccine, &c.

Facilities for Advanced Study and Research.

Arrangements are made for courses of advanced Study and Research for Colonial Veterinary Officers and others who may desire to avail themselves of these facilities.

Provision is also made for visitors to carry out specific investigations in which they are particularly interested.

Veterinary graduates who hold a degree in Science may be admitted to the course for the Ph.D. Degree, which covers three years, though in certain cases it may be reduced to two years. It is sometimes possible to take the whole course in instalments over a limited nunber of years—as for example during a number of periods of " study leave."

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(24) VETERINARY LABORATORY: MINISTRY OF AGRICULTURE AND FISHERIES.

This laboratory is situated at New Haw, Weybridge, Surrey, approximately 25 miles from London.

Nearest Railway Stations (about 1½ miles) West Weybridge and Byfleet, on the Southern Railway (about 55 minutes' journey from Waterloo Station). *Telephone:* Byfleet 130. (*Director:* Byfleet 129.)

The Foot-and-Mouth Disease Station (for experiments with large animals) at Pirbright is some 10 miles from New Haw. It is reached by Southern Railway from Waterloo, and visitors should book to Woking (5 miles distant) or Brookwood (3 miles) and arrange motor transport.

Staff.

(*a*) *Veterinary Laboratory, New Haw, Weybridge.*

Director	W. H. Andrews, D.Sc., M.R.C.V.S.
Research Officer in charge of Poultry Disease Section ..	T. M. Doyle, F.R.C.V.S., D.V.S.M.
Divisional Veterinary Inspector in charge of Diagnosis Department and general administration	W. Watt, M.R.C.V.S., D.V.S.M.
Helminthologist	E. L. Taylor, B.V.Sc., M.R.C.V.S., D.V.H.
Research Officer	N. Dobson, B.Sc., M.R.C.V.S.
Veterinary Inspector—Vaccine Department	L. E. Perkins, M.R.C.V.S., D.V.S.M.
Poultry Disease Diagnosis ..	N. H. Hole, M.R.C.V.S.

(*b*) *Foot and Mouth Disease.—Experimental Station, Pirbright*

Directed, for the Foot-and-Mouth Disease Research Committee, by Dr. W. H. Andrews.

Research Officer and Veterinary Inspector in charge of administration	T. Bannatyne, D.V.S.M.
Research Officers	G. B. Simmins, M.R.C.V.S., D.V.S.M.
	E. V. Watkins, M.R.C.V.S.
	H. S. Purchase, B.Sc., M.R.C.V.S.

Aims of the Laboratory.

This institution was founded for the purposes of applying laboratory methods to the diagnosis of disease, and of conducting research into problems of aetiology and prophylaxis. In connection with both routine diagnosis and research, attention is paid more particularly to diseases scheduled under the Diseases of Animals Acts, but other disease problems of economic importance are also investigated.

Summary of Work.

The work undertaken at present may be summarised under two heads :

Routine.

1. Diagnosis of scheduled diseases—especially anthrax, swine fever and rabies (at present only in recently imported and quarantined dogs).

2. Diagnosis of general pathological specimens submitted by veterinary practitioners.

3. Diagnosis of disease in poultry—general post-mortem examination of birds from field.—Bacillary White Diarrhœa—Cultural examination of chicks.—Agglutination tests on adult hens.

4. Preparation of anti-abortion vaccine. In this department diagnosis by agglutination is also carried out on a limited scale.

5. Redwater and Anaplasmosis vaccination of cattle to be exported to tropical and sub-tropical countries.

Research.

1. *Foot-and-Mouth Disease.* Research on this disease is carried on in various institutions under the general direction of a special scientific committee. All experiments on the farm animals are carried on at the special station at Pirbright, where extreme precautions have been taken in connection with the planning, erection and management of the station to secure the necessary isolation.

A well-equipped laboratory has recently been erected at Pirbright, and the work on Foot-and-Mouth Disease in guinea pigs and other small laboratory animals, which formerly was carried out at New Haw, has now been transferred here.

2. Swine Fever, and the differentiation of clinically similar porcine diseases.

3. Contagious abortion of cattle, including especially immunisation and methods of diagnosis.

4. Various sheep diseases, including scrapie and " swing-back."

5. Poultry diseases, and more particularly Fowl Pox, Bacillary White Diarrhœa and Tuberculosis.

6. Parasitic diseases, and especially verminous gastro-enteritis of sheep.

Various other diseases are encountered from time to time in the course of the routine work, or are specially brought to the notice of the laboratory, and are investigated as far as the other and more pressing duties of the staff will permit.

The New Haw laboratory has excellent facilities for performing experimental work on the larger farm animals.

There is extensive laboratory accommodation, and a limited number of post-graduate workers can be received.

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(25) ANIMAL DISEASES RESEARCH ASSOCIATION OF SCOTLAND.

Situated at Moredun, Gilmerton, Edinburgh. Nearest Railway Station, Edinburgh. Institute three and a half miles from Edinburgh. G.P.O. Motor 'buses pass the door. *Telephone:* Edinburgh 41744.

Staff.

Director	W. A. Pool, M.R.C.V S.
Senior Research Assistant	H. Preston, M.R.C.V.S., D.V.S.M.

Junior Research Assistant	A. Brownlee, B.Sc., M.R.C.V.S.
Second Junior Research Assistant	D. R. Wilson, B.Sc., M.R.C.V.S., D.V.S.M.
Secretary	A. R. Milroy.

The Animal Diseases Research Association of Scotland was formed in 1920, when a Committee composed of representatives of the Highland and Agricultural Society, the Scottish Chamber of Agriculture and the National Farmers' Union of Scotland provided a constitution. In 1922 the Association took over the Research Staff and the work which had been carried on in the Glasgow Veterinary College with Government help since 1917. It receives two-thirds of its expenditure from the Board of Agriculture for Scotland and has to raise one-third from private sources.

On 1st June, 1926, the laboratories were moved from Glasgow into the new Institute at Moredun, Gilmerton, Edinburgh, which had been erected from funds provided by Government.

The Institute consists of laboratories with the necessary accommodation such as sterilising and preparation rooms, stores, &c. There is good accommodation for horses and cattle and also for small laboratory animals. There are about 20 acres of grazing paddocks adjacent to the buildings. In addition to this the top floor of the Royal (Dick) Veterinary College has been fitted up specially for the Association.

Summary of Work.

The Association exists for the study of the diseases of farm live stock. So far the diseases of sheep have been given first consideration because Government support was obtained for this purpose. The diseases of other farm animals have been investigated when possible. Good results have been obtained from the investigation of braxy and lamb dysentery. Louping ill and scrapie have been given detailed attention. Other diseases of sheep such as swing-back, foot rot, gangrenous mammitis and certain inflammatory skin diseases are given a place in the programme.

Grass disease in horses is being investigated. It is hoped in future to give more time to cattle diseases. Work has already been done on contagious abortion and mammitis in cattle.

Facilities for Study and Research.

The Institute is well equipped for the study of animal diseases.

There is ample accommodation, both out-door and in-door, for the larger animals. A considerable amount of material for study is always available, and arrangements could quite easily be made for dealing with special subjects in which visiting workers may be interested.

Although the Institute is out of Edinburgh there are good transport facilities, so that lectures could be attended in one or other of the Institutions in Edinburgh.

Visiting workers would be expected to defray the cost involved in any special work carried out.

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(26) ANIMAL DISEASES DIVISION: MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

This Division is situated at Stormont, Strandtown, Belfast, five miles from Belfast on Dundonald tramway line.

Staff.

Head of Division .. John P. Rice, B.Sc., M.R.C.V.S.
Assistant .. .. Hubert G. Lamont, B.Sc., M.R.C.V.S.

Summary of Work.

Research work is in progress regarding sterility in cattle, anti-tuberculosis vaccination, pneumonia in pigs and diseases of poultry and sheep.

Cattle.—The Division has followed closely the work of Nielsen, who finds that inflammation of the womb, resulting from infection at birth or abortion, is the only important cause of sterility in cows and that the majority of cases respond to intra-uterine injections. An endeavour is being made to carry this work further by combined clinical, therapeutic, and post-mortem investigations. Bacteriological examination of diseased wombs is being carried out with a view to determining the nature of the organisms which invade the organ.

Sterility in heifers is under investigation with special reference to nodular vaginitis, which is regarded by some veterinarians as being a normal condition. The vaginal flora of normal animals is being compared with that of animals showing nodular vaginitis.

Experiments with the anti-tuberculosis vaccine of Calmette and Guerin are now in their second year. Seventy-five per cent. of calves born in a tuberculous herd are vaccinated at birth and thereafter annually, while 25 per cent. are left unvaccinated. The vaccinated and the control animals will be killed after prolonged exposure to natural infection when information will be afforded regarding the preventive value of the vaccine.

Pigs.—Losses are experienced amongst young pigs in Ireland from a condition known as "blows" and "thumps," which is frequently associated with pneumonia and, sometimes, with heart disease. While many of the cases show the presence of lung worms, these parasites are often absent, and the cause of the pneumonia

remains obscure. A bacteriological examination of the problem is being made. Attempts to transmit the non-parasitic form of the disease or diseases to healthy pigs have, so far, been unsuccessful.

Poultry.—Much time has been devoted to bacillary white diarrhœa, the most important disease of poultry. Several strains of bacteriophage active against the causal bacillus of the disease have been used for vaccination purposes. The blood or agglutination test for detecting adult carriers of the disease is being investigated with special reference to the agglutinability of the strain of *Bacillus pullorum* used as the antigen and to the dilution which indicates infection.

About two hundred wild birds have been examined by the Division for the presence of gape worms. It was found that 98 per cent. of young rooks harbour gape worms, morphologically identical with *Syngamus trachea*, which cause gapes in domesticated birds. While the rook gape worm has the same structural characters as the parasite of chicks, it may be a " host " species incapable of infecting poultry. This point has been tested by feeding chicks with rook gape worms hatched in the laboratory, and the results are in course of publication.

Sheep.—A disease known as " headles " or " hard lug " is under investigation. The popular theory that it is caused by feeding on bog asphodel is being tested.

Facilities for Study and Research.

See p. 24

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(27) INSTITUTE OF AGRICULTURAL PARASITOLOGY: LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE.

The Institute of Agricultural Parasitology is housed at Winches Farm, Hatfield Road, St. Albans, Herts. The nearest station for passengers is the City of St. Albans Station on the London, Midland and Scottish Railway, about $1\frac{3}{4}$ miles distant. Expresses from St. Pancras, London, to St. Albans City, take 30 minutes. Numerous buses pass the station and farm. *Telephone:* St. Albans 858.

The London School of Hygiene and Tropical Medicine is the parent body and occupies at present temporary premises in the Hospital for Tropical Diseases, 25, Gordon Street, W.C. 1., pending the completion (in 1929) of new premises now in course of erection in Malet Street, to the north-west of the British Museum. *Telephone:* Museum 3326 Ext. 8.

Winches Farm occupies 48 acres, of which about 23 acres are under grass, three acres woodland and 22 acres arable, of which 10 acres are being laid to grass.

Staff.

Director	Prof. R. T. Leiper, M.D., D.Sc., F.R.S., Professor of Helminthology in the University of London and Director of the Division of Medical Zoology in the London School of Hygiene and Tropical Medicine.
Principal Research Assistant	T. Goodey, D.Sc.
Senior Assistant	D. O. Morgan, M.Sc.
Field Naturalist	J. N. Oldham, B.Sc., Ph.D.
Field Officers	M. Triffitt, M.Sc., and E. Aneurin Lewis, M.Sc.
Veterinary Adviser	T. W. M. Cameron, M.A., D.Sc., Ph.D., M.R.C.V.S.

Summary of Work.

The Institute specialises in the morphology, life-histories and bionomics of the internal parasites of domesticated animals, farm stock, poultry and fur animals—and of the allied eelworms which infest plants of economic importance ; with special reference to those factors which have direct bearing on their control or eradication. Correlated studies are made on the host reactions induced by the migration of larval and adult forms within the hosts and of the bionomics of the intermediate hosts concerned in the spread of the chief entozoal diseases.

Efforts are being made to study not only the normal life cycles of the more important parasites but to ascertain the effect of varying conditions of climate, soil, etc., on the extent and duration of soil infectivity. Tenth-acre field plots have been established of eelworm infestation of daffodil, wheat and strawberries. Paddocks containing infection with specific entozoal diseases such as Husk, Hookworm in Sheep, Trichinosis, "Gapes," etc., are being established. Reservoir infections of the different kinds of tapeworm of the dog which are transmitted through domesticated and food animals are in course of formation for future studies. Much of the research work in progress is theoretical and will necessarily continue to be so, as this provides a fundamental basis of exact knowledge upon which the practical application to disease control must be based, but an extension is in contemplation, as a result of an anonymous benefaction, to enable field work on chemo-therapy to be undertaken.

Facilities for Advanced Study and Research.

The Institute of Agricultural Parasitology is a subsidiary of the London School of Hygiene and Tropical Medicine, and comprises a staff of five whole-time research workers under the direction of Professor R. T. Leiper, F.R.S., who is also the Director of the Division of Medical Zoology in the London School of Hygiene and Tropical Medicine (University of London).

Facilities for advanced study and research are available for overseas workers in the Departments of Helminthology, Protozoology and Entomology in the Medical Zoology Division. Supervision of research workers is undertaken by the Directors of these Departments.

Application should be made for detailed information regarding special courses of instruction, facilities for research and for supervision of the degrees of M.Sc., Ph.D., and D.Sc., by thesis in the University of London, to the Secretary of the London School of Hygiene and Tropical Medicine.

D.—Animal Husbandry.

(28) ANIMAL NUTRITION RESEARCH INSTITUTE: CAMBRIDGE UNIVERSITY

The laboratory work of the Institute is carried on mainly at the School of Agriculture, Downing Street, Cambridge, but the Institute possesses a branch laboratory at the Field Laboratories, Milton Road. The experimental animals are kept at the Field Laboratories, at Howe Hill Farm, Huntingdon Road, and a few are actually under observation at the School of Agriculture. The nearest railway station is Cambridge, which can be reached in 1½ hours from London, either from Liverpool Street or from King's Cross. Communications should be addressed to Professor T. B. Wood, School of Agriculture, Cambridge. *Telephone*: Cambridge 1885 (two lines).

Staff.

Directors	Professor T. B. Wood, C.B.E., M.A., LL.D., F.I.C., F.R.S., Drapers Professor of Agriculture in the University.
	F. H. A. Marshall, Sc.D., F.R.S., Reader in Agricultural Physiology in the University.
Consultants	Sir F. G Hopkins, M.D., LL.D., F.R.C.P., F.R.S., Professor of Biochemistry in the University.
	J. W. Capstick, O.B.E., M.A., D.Sc, Fellow of Trinity College.
	G. Udny Yule, M.A., F.R.S., University Lecturer in Statistics.
Principal Assistants:—	
Chemist	F. W. Foreman, M.A., F.I.C.
Physiologists ..	J. Hammond, M.A.
	E. T. Halnan, M.A.

Senior Assistants :—

Chemist	.. ..	H. E. Woodman, D.Sc., Ph.D.
Physicist	.. ..	T. Deighton, Ph.D., B.Sc.

Assistants :—

Physiologist	.. ..	Vacant.
Statistician	.. ..	H. G. Sanders, Ph.D.
Agriculturist	..	I. S. Morgan, M.A.

Summary of Work.

The work of the Institute is organised on two main lines ; nutrition proper, under Professor T. B. Wood, and the physiology of reproduction and growth under Dr. F. H. A. Marshall.

Nutrition proper.—The central idea behind the work of Professor Wood's team has been, throughout the existence of the Institute, the establishment of quantitative relations between the consumption of food and the production of live weight increase in growing and fattening animals. The broad question has been attacked from many points of view :—calorimetric observations have been made, more especially on growing pigs, to determine the maintenance requirements : comparative slaughter investigations have been carried out on pigs, sheep, cattle and fowls to determine the composition of the live-weight increase : statistical studies of the records of feeding experiments have been used with success to ascertain both the maintenance requirements and the composition of live weight increase, more especially in the case of sheep : many digestibility determinations have been carried out with pigs, sheep and poultry in order to ascertain the real nutritive value of such feeding stuffs as the various grades of millers' offals, cooked and uncooked maize, silage prepared by various methods and by standard methods from different crops, and especially freshly cut grass from different pastures.

The results of these investigations have enabled the Director to propose a method of rationing pigs, sheep and cattle on the basis of maintenance requirement adjusted according to live weight plus production requirement adjusted according to the desired rate of live weight increase. The method, with the various data necessary for its use, is set out in Rations for Livestock, by Professor T. B. Wood, Ministry of Agriculture's Miscellaneous Publication No. 32, 5th edition, 1927.

In addition to this main series of investigations, members of Professor Wood's section have carried on specialist detailed studies : Mr. Foreman on protein chemistry, Dr. Woodman on the process of ensilage, Mr. Halnan on poultry nutrition, Drs Capstick and Deighton on the construction and standardization of animal calorimeters.

Finally many detailed papers on allied subjects have been published by research students.

Reproduction and Growth.—The broad idea of the investigations undertaken in this subject is to get a complete knowledge of all the reproductive processes of farm animals and the conditions governing the development of the young. By so doing it is hoped to obtain practical control of the factors regulating fecundity and the periodicity of breeding as well as those affecting the growth and proportions of the different organs and parts of the body. The importance of such knowledge to the farmer needs no emphasis, and its practical value has already been demonstrated. The chief practical results so far obtained have been outlined in the Research Monograph on " The Physiology of Animal Breeding, with special reference to the Problem of Fertility," recently issued by the Ministry of Agriculture and Fisheries. The details of an extended investigation on " The Physiology of Reproduction in the Cow," by Mr. J. Hammond, have just been published. The bearing of the work on problems of milk production and practical dairying are sufficiently apparent, for it is believed that by controlling the periodicity of breeding it will be possible to regulate the milk supply throughout the year and to obtain increased yields in the winter. Similar work has been carried out by Dr. Marshall, Mr. Hammond, Dr. Asdell and other investigators at the School of Agriculture on the sheep, the goat, the pig, the dog and the smaller animals of the farm, and Mr. Hammond has begun an enquiry on the reproductive processes in the mare, an animal that shows an unusually high percentage of sterility, the causes of which stand in urgent need of investigation. At the same time Dr. Sanders is engaged in work on the statistical side of these problems. He has already published the results of enquiries into the various factors affecting milk yields in cows and the fertility of stallions.

Facilities for Advanced Study and Research.

Advanced Study.—Members of the staff of the Institute give advanced courses of lectures on the chemistry and physiology of nutrition and on the physiology of reproduction and growth. Advanced students may also attend lectures and practical courses in the Department of Physiology and Biochemistry.

Research.—The Institute is well equipped with the means for research in the above subjects. Its equipment includes :—Laboratories for research in nutritional chemistry, apparatus for digestibility and metabolism experiments, calorimeters for large and small animals, and buildings for feeding experiments ; also laboratories for physiological work and buildings for keeping experimental animals.

Admission.—Graduates who can spend some time in Cambridge may be admitted to :—

(i) The post-graduate course for the Diploma in Agricultural Science which covers one or two years at the discretion of the Degree Committee of the Faculty Board.

(ii) The course for the Ph.D. degree, which covers three years, though in certain cases it may be reduced to two years.

Members of the staffs of Teaching Institutions or of Government Departments of Agriculture may be given permission to work in the Institute for shorter periods ; but it is not in any case possible to obtain a diploma or degree in shorter periods than those specified above.

Candidates for degree or diploma are placed under the direct supervision of a senior member of the staff, who is responsible for directing their research.

Requests for admission should be directed to the Secretary, School of Agriculture, Cambridge, as long as possible before proposed arrival in Cambridge.

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(29) ROWETT RESEARCH INSTITUTE.

This Institute is situated at Bucksburn, Aberdeen. The nearest railway station is Bucksburn. *Telephone :* Bucksburn 8.

This Institute is devoted to Research in Animal Nutrition and was formally opened by H.M. The Queen in September, 1922. Its large modern buildings, situated within five miles of the City of Aberdeen, consist of Laboratories and Experimental Rooms for Physiology, Biochemistry, Pathology and Animal Husbandry, a well-designed set of animal houses for feeding experimental animals and a library equipped with facilities for preparing and indexing records and the compilation of statistical data. In addition to grants from Government and other sources, the late Dr. J. Q. Rowett contributed £12,000 towards the capital cost of these buildings and Mr. Walter A. Reid gifted £5,000 for the endowment of the Library and Statistical Department.

An experimental stock farm is being established at present in connection with the Institute to provide facilities for testing and applying, under practical conditions, those results of research in animal nutrition which appear to be of economic value. In 1925 Mr. J. Duthie Webster gave a donation of £10,000 to found a trust, the income of which is directed to be used for the furtherance of the work of the experimental stock farm. Most of the land required has been purchased and some of the necessary buildings erected. The rest of the work will be proceeded with so soon as the necessary funds required for capital expenditure have been raised.

Staff.

Director	J. B. Orr, D.S.O., M.C., M.A., M.D., D.Sc.
Secretary and Treasurer..	E. G. Bruce, M.A., B.Sc. (Agric.).
Librarian and Statistician	J. S. Thomson, M.A., B.Sc., A.I.C.

Biochemical Department	W. Godden, B.Sc., F.I.C. (Head).
	Miss M. B. Richards, M.A., D.Sc.
	Miss B.W. Simpson, M.A., B.Sc.
Physiology Department ..	H. E. Magee, M.B., Ch.B., D.Sc. (Head).
	J. M. Henderson, M.A., M.B., Ch.B., D.Sc.
	Miss I. Leitch, M.A., D.Sc.
	Miss E. M. Cruickshank, B.Sc., Ph.D.
	Miss J. McCallum, B.Sc.
Pathology Department ..	J. P. McGowan, M.A., B.Sc., M.D. (Head).
Animal Husbandry Department	A. Crichton, M.A., B.Sc. (Agri.) (Head).
	J. A. Crichton, M.A., B.Sc. (Agri.).
	W. Middleton, N.D.A., U.D.A.
	Miss M. Moir, N.D.A., U.D.D.

Summary of Work.

The main work of this Institute consists on the one hand of investigations into the energy and material requirements of farm animals under conditions of maintenance and various kinds of production and the best means of meeting these requirements ; and on the other hand of investigations into the constitutents of and the digestibility and nutritive value of various feeding stuffs. The main trend of the present research policy of the Institute is the investigation of problems connected with the mineral metabolism of farm animals. In this connection, work has been carried out, among other things, on :—

(1) The mineral content of pastures.
(2) Iodine.
(3) Nutritive properties of milk.
(4) Human dietetics.
(5) The mineral content of feeding stuffs.

The Mineral Content of Pastures.—A large number of analyses of pastures from different areas at home and abroad has been carried out at the Institute, and the data show that there are marked differences in the mineral content of good and poor pastures, particularly with regard to calcium, chlorine and sodium. Seasonal variations in the mineral content of any given pasture were also observed, and clinical observations on the areas of collection indicated some correlation between the occurrence of disease and low mineral content of pastures. Practical feeding experiments with sheep are in progress in certain areas in Scotland to determine whether the supplementing of poor pastures by the addition of minerals in the food will result in an improvement in the rate of growth and the health of the sheep grazing thereon.

These feeding experiments, so far as they have gone, seem to indicate that the addition of mineral matter has had a beneficial effect on the health of ewes. At lambing time, they were in better

condition than control groups. The average weight of the lambs at birth was also greater. There was a definite increase, in some cases up to 10 per cent., in the weight of the fleeces in the groups receiving the mineral supplement over control groups. This beneficial effect of feeding extra mineral matter was more marked in the spring following the winter period when the mineral content of the pasture is lowest.

Investigations on such lines are being carried out in different parts of the Empire. Under a grant from the Empire Marketing Board, experiments are being carried out in Kenya Colony and the results being obtained are comparable with the results in Scotland.

The whole of the literature on the subject of the mineral content of pastures and its relationship to disease is being reviewed and a booklet will be published shortly for circulation amongst those at home and in different parts of the Empire, who are interested in this problem.

Iodine.—Previous work has shown : (*a*) that there are considerable differences in the iodine content of pastures, soils and water in different areas in this country ; some pastures are five or six times as rich in iodine as others ; (*b*) that the iodine content of milk appears to be variable ; (*c*) that the iodine content of milk is dependent upon the iodine content of the food ; and (*d*) that the iodine content of colostrum is very high compared with milk secreted later. This work on iodine metabolism has been continued and it has been found that there are differences in the amount of iodine present in both vegetable and animal products in different parts of the country. In most districts, there appears to be sufficient iodine in the foodstuffs to meet the requirements of farm animals. In a few districts, however, especially in areas where goitre is prevalent in human beings, it is doubtful whether the amount of iodine present in the food is sufficient.

A systematic investigation of the iodine content of the herbage and of animal products, such as milk and eggs, in goitre and non-goitre areas is being carried out under a grant from the Nutrition Committee of the Medical Research Council.

In addition, a large number of feeding trials, based on the results of laboratory experiments, have been conducted with a view to determining the optimum dose of iodine for growth.

Nutritive Properties of Milk.—During the past year, investigations have been carried out at various centres in Scotland to test the effect on the health and rate of growth of feeding extra milk to school children. It was found that the addition of from half to one pint of milk per day was followed by a definite increased rate of growth and in most cases there was a distinct improvement in the condition of the children. This beneficial effect was obtained with either whole or separated milk, but the feeding of biscuits of equal caloric or energy-yielding value to the amount of separated milk fed

had no beneficial effect. These findings confirm results which have been previously obtained at this Institute on farm animals and are of importance both from the point of view of the health of children and of the milk industry in this country.

Human Dietetics :—In connection with the investigation of deficiency diseases in stock in Kenya, which is being directed from this Institute, certain problems arose in connection with the feeding of natives and the Institute has co-operated with the Kenya Medical Service in investigating these problems. Chemical analysis of native foods has shown that they are deficient in certain nutrients and the adjustment of the native diets in the case of prisoners and labour gangs appears to be followed by beneficial results on the health of the natives.

The Mineral Content of Feeding Stuffs.—The object of this investigation is to obtain reliable information as to the mineral content of feeding stuffs most commonly used in agricultural practice in this country. Many of the feeding stuffs made from tropical products and commercial by-products are known to be markedly deficient in certain mineral constituents and as these feeding stuffs are commonly used in intensive feeding in this country, the results of this investigation, when published, will provide farmers and others with a working basis for compounding rations.

Other Work.—In addition to the above work, which is of immediate practical interest, progress is being made with research on fundamental problems in nutrition. The effects of different dietary constituents on the movements of the intestines are being investigated. It has been found that diets with deficiency or excess of certain constituents lead to abnormal intestinal movements and it seems probable that this derangement of the function of the intestine may be an important pre-disposing cause of disease. Work on the influence of minerals, vitamins and ultra-violet rays on the composition of the circulating fluids of the body is yielding information of interest in connection with certain diseases originating in faulty diet. The question whether the abnormal composition of the blood due to defective diet is a pre-disposing factor in certain infectious diseases, rendering the animal more susceptible, is being studied.

A large number of feeding experiments with poultry have been carried out in connection with the three Colleges of Agriculture in Scotland and the Department of Agriculture for Northern Ireland to discover the best and most economic rations for growth in chickens and for egg-laying.

Facilities for Research.

Rowett Institute.—The Institute is equipped for carrying out fundamental research in Animal Nutrition. It is organised into the following departments : Biochemistry, Physiology and Pathology.

There is accommodation for from 15 to 20 research workers in the laboratories. Attached to the Institute are animal houses where feeding and " balance " experiments can be carried out under exact conditions.

Experimental Farm.—The Duthie Experimental Farm is being established for carrying out practical experimental work in Animal Husbandry. When completed, the farm will comprise departments for pigs, poultry, sheep, beef cattle and dairy cattle. The pig, dairy and poultry departments are already established and it is hoped that the beef cattle and sheep departments will be in operation next year. There are about 800 acres of land attached to the farm and the present stock consists of 500 pigs, 600 sheep, 90 dairy cows and 1,000 head of poultry.

Reid Library.—A library is attached to the Institute where members of the staff may consult books and journals on the subject of nutrition.

The work of the Institute is confined to research. In addition to the permanent staff of research workers, there are always some post graduate research scholars and graduates in training for research. No teaching work is done for degrees in science or agriculture but the research work carried out is accepted as a qualification for post graduate University degrees.

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(30) NATIONAL INSTITUTE OF POULTRY HUSBANDRY (HARPER ADAMS AGRICULTURAL COLLEGE, NEWPORT, SALOP).

Director	Professor Raymond T. Parkhurst, B.Sc. (Agr.), M.Sc.
Assistant Director ..	H. Howes.
Research Assistant ..	E. B. Lomax, B.A. (Cantab.), N.D.P.
Assistant Lecturer ..	Miss Dorothy MacFadzean.
Senior Practical Assistant	E. W. Fogden.
Assistant	W. King Wilson.
Statistician	F. J. Dudley, B.A., Dip. Agric.

This Institute, established in 1924, is the largest section of the National Poultry Institute Scheme, and is specifically charged with the carrying out of large-scale experimental work on the breeding, feeding, management and housing of poultry and other small livestock.

The Institute occupies a site of 26 acres on the College farm, and has been equipped at a cost of £15,000, exclusive of plant and livestock provided by the College. The head of livestock comprises some 1,500 poultry, 300 ducks, and small flocks of geese and turkeys The Rabbit Department is a self-contained unit with accommodation for some 250 rabbits, available for studies of fur and wool production.

Experimental work in progress includes nutrition studies relating to chick-rearing and egg-production, methods of housing and management, influence of ultra-violet radiation on growth and egg-production, etc.

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(31) [CHEMICAL AND] ANIMAL NUTRITION DIVISION: MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

For particulars of situation, staff and soil work, *see* p. 23.

Summary of Work.

Beef Production.—Work has been in progress since 1922 on the production of baby beef, that is fat cattle suitable for the butcher, weighing from 7 to 10 cwt. at from 14 to 18 months old. Experimental results have been published demonstrating that the production of " baby beef " is a more profitable venture than the prevailing practice of rearing store cattle for export to Great Britain at ages varying from 18 months to 3 years.

Experimental work is in progress with the object of determining :

(1) The maximum extent to which home grown foods such as oats can be utilised in the rations.
(2) The influence of the " bulk " of the ration on the daily liveweight gains.
(3) The extent to which May and June dropped calves can be reared and fattened on the grass for baby beef production.
(4) The possibility of increasing the liveweight gain beyond the usual rate of 2 lb. per head per day.

This work has been undertaken because it is felt that the future of the beef trade lies with medium weight cattle and that there will probably be a steadily decreasing market for 2½ to 3 year old heavy weight beef cattle.

Milk Production.—The problem of maintaining a Grade A (T.T.) herd of heavy milking cows is being explored from the point of view of freedom from tuberculosis, sterility and abortion For this purpose a herd of 44 cows has been split into two groups A and B, and half the byre glazed with Vitaglass. Group A receives a mineral mixture in its ration during the winter feeding period. Half the cows in Groups A and B are housed during the winter in the Vitaglass portion of the byre and the remaining half in the portion glazed with ordinary glass.

Data concerning milk yield, calf weights, reactions to Tuberculosis tests, periods of gestation and service records are being kept.

Calves.—Work on the rearing of calves for baby beef production and on the rearing of heifers for subsequent milk production will shortly be started.

Pigs.—Two problems are being investigated: (1) the cause of the difficulties experienced in maintaining a large breeding herd of pigs and of rearing and fattening their litters when no milk or only a relatively small quantity of milk is available. A preliminary report of this work has been published. (2) The influence of feeding on the type and quality of the bacon.

Sheep.—In collaboration with the Rowett Research Institute an inquiry is in progress as to effect of feeding on birth rate, mortality and growth of the lambs, and of feeding a mineral mixture to mountain breeding ewes during the period October to April.

Poultry.—Experimental work is being carried out on the following, amongst other problems :—

(1) The protein and mineral requirements of heavy laying pullets.
(2) The effects of feeding on the number and size of the eggs.
(3) Vegetable *versus* animal foods as a source of protein for laying birds.
(4) The mineral requirements of growing chicks.
(5) The effect of a high and a low level of nutrition on the rate of maturity of the young pullet and on the subsequent egg production.

This work is being conducted in collaboration with the Rowett Research Institute and the Poultry Departments of the Scottish Agricultural Colleges. Preliminary results have been published.

Silage.—An investigation on the feeding value of silage for dairy cows has been completed and the results published.

Facilities for Study and Research.

See p. 24.

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(32) [CROP AND] ANIMAL HUSBANDRY RESEARCH DIVISION: MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

Staff.

Head of Division .. .. R. Rae, B.Agr.

This Division commenced operations in January, 1926. The research work of this division is concerned mainly with farm management problems, and is carried out chiefly at the Agricultural Research Institute of Northern Ireland, situated at Hillsborough, County Down, to which reference is made on page 87.

Very full and detailed cost accounts of every branch of the farm are being kept. The extraction of information from these is in

hand in connection with animal husbandry problems such as systems of management for the production of baby beef under North of Ireland conditions.

Arrangements have been made and facilities provided for trials of new farm machinery to be carried out and records of their performance taken. Investigations are also contemplated into methods and types of cultivation.

The management of the Dairy Herd, which is licensed for the production of Grade A (T.T.) milk, is being controlled with a view to collecting data as to the incidence of tuberculosis, sterility and abortion. The division is co-operating with the Animal Nutrition Division in the control of this experiment.

Facilities for Study and Research.

See p. 24.

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(33) AGRICULTURAL RESEARCH INSTITUTE: MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

The Agricultural Research Institute, situated at Hillsborough in County Down (about twelve miles from Belfast and about one mile from Hillsborough Station), consists of an experimental farm of almost 500 acres. The station is controlled by a Board of Trustees who will have an endowment fund producing an income of approximately £3,000 per annum.

Possession of the farm was obtained by the Trustees in April, 1927, and the station is in process of being equipped mainly for the development of work on animal nutrition. For particulars of the work see under Chemical and Animal Nutrition Division, pages 23 and 85, and also Crop and Animal Husbandry Division, page 86.

Joint Directors	Research and Experiments	G. S. Robertson, D.Sc., F.I.C.
	Management	Robert Rae, B.Agr.
Costings and Records		R. W. Hale, B.Sc.

A station for research in Poultry Nutrition is in course of erection at Hillsborough, Funds for the equipment and maintenance of this station have been provided by the Empire Marketing Board. When complete the station will provide 40 experimental laying pens each providing accommodation for 25 birds and 20 experimental chicken rearing pens with accommodation for 2,000 chickens.

Manageress	Miss H. C. Walker.
Assistant	Miss N. Woods.
Research Assistant	J. H. Prentice, B.Sc., B.Agr.

Facilities for Study and Research.

See p. 24.

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(34) THE NATIONAL INSTITUTE FOR RESEARCH IN DAIRYING.

Shinfield Manor House, the Headquarters of the Institute, is about four miles from Reading Stations, G.W.R. and S.R., and within half an hour's walk of the Reading Corporation motor 'buses which pass the Reading Railway Stations on their way to and from Shinfield. *Telephone :* Spencers Wood 3.

In the Manor House are the Dairy Chemistry and Dairy Bacteriology Laboratories, the Library, the offices of the Dairy Husbandry Department and the Administrative offices.

Church Farm, the experimental farm of the Institute, is close to the Manor House, and the fact that old and modern buildings exist side by side is a feature which is of considerable interest to visitors. The buildings comprise stabling and barns, an old cowshed which was in use when the Institute first obtained its licence to produce "Grade A Tuberculin Tested Milk" and newly-erected buildings consisting of cowsheds, bull pens, calf pens and feeding stores, milking shed and dairy.

Staff.

Director .. .. .. R. Stenhouse Williams, M.B., C.M., D.Sc., D.P.H., L.R.C.P. and S.E.

Bacteriological Department :—

Professor R. Stenhouse Williams (*Head*).
A. T. R. Mattick, B.Sc. (Agric.).
Edith R. Hiscox, M.Sc. (London), B.Sc. (Bristol).

Chemical Department :—

Capt. J. Golding, D.S.O., Chevalier de Merite Agricole, F.I.C. (*Head*).
Mrs. E. C. V. Mattick, M.Sc., Ph.D.

Dairy Husbandry Department :—

J. Mackintosh, O.B.E., N.D.A., N.D.D. (*Head*).
S. Bartlett, M.C., N.D.D.

Aims of the Institute.

Within the province of the Institute are included all questions relating to the production, handling and distribution of milk, and the manufacture of dairy products. These involve the study of the constitution of the land and of the food stuffs which are grown upon it ; of the management and feeding of dairy herds ; of the methods of handling and distributing milk ; and of the technical processes involved in the making of such products as butter and cheese. From

such studies it is possible to obtain a knowledge of the value of the land in the production of feeding stuffs, the influence of the feeding stuffs upon the cow and upon her milk production and of the value of the milk both as a food stuff and as a medium for preparing dairy products.

Summary of Work.

In order that the value and effect of foodstuffs fed to cattle may be understood, studies are being made of the botanical and chemical constitution of various foods, and the effect thereon of different methods of cultivation and manuring. The field experiments deal with (*a*) the yield, dry matter content, and keeping qualities of varieties of mangels ; (*b*) the effect of surface cultivation on limiting the growth of weeds in lucerne during the first and second seasons' growth; (*c*) the nitrogenous manuring and heavy stocking of pasture land grazed by cows ; and (*d*) the suitability of different mixtures of cereals and pulse crops for silage.

Experiments are being conducted on the feeding of stock, including investigations (*a*) on the rations required to rear yearling heifers ; (*b*) on the effect of certain winter rations on the vitamin content of milk ; (*c*) on the effect of additional oils, *e.g.*, cod-liver oil, on the percentage of fat in cows' milk.

The feeding values of milk and its products are also being investigated. The vitamin value of butter made from the milk of experimentally fed cows is being studied by the carrying out of extensive rat feeding experiments. Experiments are also being conducted on the value of whey, dried whey and other dairy by-products as an addition to the diet of pigs. Further experiments will be made, designed to differentiate between the relative nutritional value of the components of milk as judged by pig feeding. The effect of heat on the value of milk, as shown by feeding to rats, is also being studied.

Experiments are being conducted in order to study the influence of the different methods of the handling of milk, on cream, butter and cheese. In this connection it has been necessary to carry out a number of experiments on the use of different types of " starter " in the making of butter and cheese and on the influence of these upon the quality of the dairy products obtained.

By these means a picture is being obtained of the influence of the land upon the food stuff, upon the cow and the milk that she gives and the products which are made from that milk.

In the course of the work it has been found that the methods of handling milk both in the cowshed and at the dairyman's premises have a great influence on the quality of the final product, and, therefore, prolonged studies have been made of methods of hand and machine milking ; of the effect upon the cleanliness of the milk of steaming dairy utensils ; and the influence of methods of carriage and transport upon the final condition of the milk. In this connection members of the staff have conducted investigations

both at the farms where the milk is prduced, and at the retailer's premises in Reading, London, and elsewhere, to which it is delivered, so that a complete picture may be obtained.

As time has progressed it has also become clear that dairy machinery and appliances play an important part in the production, handling and distribution of milk and its products, and it is important that they shall be efficient for the purposes for which they are designed. Tests of efficiency are, therefore, made for the benefit of the makers, and as time goes on, this work should tend to prevent the sale of machinery and utensils which, while they may be mechanically efficient are not necessarily satisfactory from the point of view of the industry. Among the articles tested have been milking machines, separators, bottle washing machines, milk coolers, churns, covered milking pails and milking stools, &c.

Further, many of the immediate problems of the industry are being studied, such as taints in milk whether from foodstuffs, metals or bacteria and faults which are found to occur in butter and cheese ; as, for example, fishiness in butter, red and black spot in cheese, &c.

Facilities for Study and Research.

The Institute is organised in the following departments :— Bacteriological, Chemical and Dairy Husbandry. It possesses laboratories, a dairy and farm for carrying out the necessary work ; and undertakes the study of methods of breeding and feeding for milk, of milk production and the value of milk under varying conditions, both as a food stuff and as a medium for the preparation of dairy products. It also undertakes the testing of dairy machinery and much advisory work.

Admission.—Graduates who can spend some time in Reading may be admitted to courses for M.Sc. and Ph.D. degrees in the University which cover two and three years respectively, although in certain cases these periods of time may be reduced in each case by one year.

Voluntary workers may be given permission to work in the Institute for shorter periods. Those who wish to do so should communicate in the first instance with the Director of the Institute stating the department in which they wish to work and the probable length of their stay.

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(35) HANNAH DAIRY RESEARCH INSTITUTE, AYR.

The " Hannah " Dairy Research Institute has just been founded. It will be situated at Auchincruive near Ayr, and will be contiguous to the West of Scotland Agricultural College.

There is at present only an Interim Director. Dr. N. C. Wright has been appointed Physiologist to the Institute. The plans for the new laboratories are now in preparation.

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(36) DAIRY BACTERIOLOGY DIVISION: MINISTRY OF AGRICULTURE, NORTHERN IRELAND.

This division is situated at the Queen's University, Belfast.

Head of Division	..	George Wilson, M.R.C.V.S., D.V.S.M.
Assistant ..	..	L. A. Allen, B.Sc.

Summary of Work.

This Division commenced operations in October, 1927, and the work is still in the initial stages of development. The main work of the division may be grouped under two headings :—

I. *Graded Milk.*

Under the Sale of Milk (Special Designations) Act which came into operation on Januray 1st, 1928, the only licensed milk in Northern Ireland is that complying with the designation Grade A Tuberculin Tested. It is the function of the Division to stimulate the production of Grade A tuberculin tested milk, to work out the problems connected therewith and to carry out for the licensing authority, namely the Ministry of Home Affairs, the examination of all official samples.

II. *Creameries.*

The production of creamery butter of a uniform standard quality is to a large extent dependent upon the cleanliness of the milk supply received by the creameries. It is the function of the Division to devise methods for the improvement and control by the creameries of this supply. The Division also affords advisory services to the creameries in connection with bacteriological problems.

Facilities for Study and Research.

See p. 24.

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(37) SMALL ANIMAL BREEDING RESEARCH INSTITUTE: CAMBRIDGE UNIVERSITY.

Laboratory work of this institute is carried out at the School of Agriculture, Downing Street, Cambridge, and field work at the University Experimental Farm, Huntingdon Road, Cambridge.

Staff.

Director ..	..	Prof. R. C. Punnett, M.A., F.R.S.
Assistant ..	..	M. S. Pease, M.A.

Summary of Work.

The following investigations are in hand :—

(*a*) *Rabbits* :—

(1) Inheritance of yellow fat. The genetical nature of this is now clear, but publication is being held up until the nature of its linkage in the albino series is determined, and until certain chemical investigations have been finished.

(2) Experiments on the linkage of Angora wool with certain coat patterns.

(3) Experiments on the genetical nature of precocity in sexual maturity and on litter size.

Series (2) and (3) have been recently started and will expand as hutch room becomes available through the gradual conclusion of (1).

(*b*) *Poultry* :—

(1) Experiments for testing whether there exist sex-linked factors affecting fecundity in the hen. These are making progress, but it must be some years before a definite result can be obtained.

(2) Inheritance of certain comb characters.

(3) Experiments to test whether the strength of linkage depends on the age of the bird.

(4) Experiments on the nature of barring factors.

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(38) ANIMAL BREEDING RESEARCH DEPARTMENT: EDINBURGH UNIVERSITY.

This Department is stationed in King's Buildings, West Mains Road, 1½ miles from G.P.O. *Telephone :* Edinburgh 42567.

For the present the Department is housed in the Chemistry Block, but plans for its own building have been prepared and the actual construction is now commenced. In the meantime six laboratories are available and are equipped for experimental avian and mammalian sex-physiology, for herd book analysis and for genetical experimentation. There are colonies of mice, rats, guinea pigs and rabbits and some 30 acres of land around the Department are used to the fullest advantage. There is an admirably equipped Pig Testing Station, a goat dairy and a poultry plant with 500 head of stock.

There is also a small flock of sheep and for work relating to the latter a sheep-building with an operating theatre is in course of erection.

Staff.

Director	.. ..	Prof. F. A. E. Crew, M.D., D.Sc., Ph.D.
		A. W. Greenwood, M.Sc., Ph.D., A. D. Buchanan Smith, M.A., M.Sc., B. P. Wiesner, Ph.D., W. F. C. Miller, M.R.C.V.S., A. Calder, Ph.D., B.Sc., N.D.A., J. S. S. Blyth, B.Sc., Ph.D.
Secretary	.. ..	S. I. Russell, M.A., B.Sc.

Aims of the Department.

It is the function of the Department to secure and broadcast knowledge relating to the physiology of reproduction and of inheritance, with special reference to the animals of economic importance. The methods employed are :—

(1) The genetical analysis of breeds and present-day breeding methods.

(2) The search for new knowledge by means of planned experimentation with convenient material.

(3) The experimental application of principles and practices which have resulted from the study of laboratory animals to the case of the animals of the farm.

Summary of Work.

The following are examples of problems now being investigated :—

(1) The genetical aspects of sterility in domestic animals.

(2) The mode of inheritance of defects (*e.g.*, hernia, hermaphroditism) and of disease resistance in domestic animals.

(3) The mode of inheritance of milk quantity and quality in the goat.

(4) The physiology of reproduction and of growth in the pig. The analysis of the hereditary constitution of the pig. The exact definition of the " Ideal Pig," and the methods of breeding such. Advanced Registry. The Ton litter.

(5) The biology of the fleece of the sheep. The structure of the component fibres of the fleece. The effect of environmental influences on fleece characters. The inheritance of fleece characters. The development of the fleece. The relation of birth fleece to adult fleece.

(6) The genetical analysis of the making of the breeds of cattle and horses, *e.g.*, the role of inbreeding in the making of the Clydesdale and the Aberdeen-Angus.

(7) The sex-physiology of the fowl. The significance of sex-reversal and of intersexuality. Fecundity and fertility.

(8) The mechanism of sex determination in domestic animals. The sex-ratio and the question of its control.

(9) The wool of the Angora rabbit. Its structure and development. The effect of environmental agencies thereupon.

(10) Fundamental studies of the physiology of reproduction and inheritance in the fruit-fly, the mouse, the rat, the guinea-pig, and the rabbit.

Facilities for Advanced Study and Research.

I. *Advanced Study.*

Lecture courses are given by members of the staff in the following subjects :—

(1) Genetics in relation to Agriculture (Animals and Plants) 50 Lectures. October to March.

(2) Genetics in relation to Livestock Breeding. 25 Lectures October to December.

(3) Genetics. Systematic and practical. 25 Lectures.

(4) Sex Physiology. (In the Physiology Department.) 10 Lectures. April to June. (No fee.)

The fee for each course except (4) is £3 3s. plus the usual matriculation fee of the University.

II. *Research.*

The Department is equipped for research into the above subjects with the exception of Plant Genetics. A large pig building accommodates experimental pigs and also serves as a pig testing station for advanced registry. There is a goat house complete with dairy and a sheep-house with operating theatre, pens, loose boxes, etc. Five hundred head of poultry are kept for the study of avian sex physiology and colonies of rats, mice and rabbits are maintained as well as Drosophila melanogaster. A member of the staff maintains close contact with practical breeders of animals of economic importance all over the country and herd and stud books are accessible.

III. *Admission.*

(*a*) Accommodation is provided for graduates who desire to proceed to one of the higher degrees of Edinburgh University (Ph.D. or D.Sc.). Candidates for these degrees work under the supervision of a member of the staff of the Department and eventually submit a thesis. No fixed laboratory fee is charged but the cost of material must be found. In addition the ordinary Matriculation fee of £2 12s. 6d. must be paid to the University and a further fee of £10 10s. when a thesis is submitted.

(*b*) Provision is made for workers such as officers of the Colonial Agricultural and Veterinary Services who desire to acquire some

special technique or who desire to spend a short period in becoming acquainted with modern problems of the subject. No fee is charged but again the cost of material must be found by the worker or his employer.

(*c*) Senior research workers may bring their own problems to work on at the Department and at the same time become acquainted with problems cognate to their own and undergoing examination by members of the staff.

Candidates for admission should apply to the Secretary, Animal Breeding Research Department, Edinburgh University, as long as possible before the date of their proposed arrival.

E.—Agricultural Economics.

(39) AGRICULTURAL ECONOMICS RESEARCH INSTITUTE: OXFORD UNIVERSITY.

This Institute is situated in Parks Road, Oxford. Nearest railway station, Oxford. *Telephone:* Oxford 2775.

Staff.

Director	C. S. Orwin, M.A.
Advisory Economist ..	A. Bridges, M.A.
	R. N. Dixey, B.A.
	G. Frecheville, B.A., M.A.
	J. R. Lee, B.Sc.
	J. P. Maxton, M.A., B.Sc.
	F. J. Prewett, M.A.
	D. Skilbeck, B.A.
	S. J. Upfold, M.C.

Aims of the Institute.

The study of the structure of the agricultural industry and of the organisation of the farm is a comparatively recent development of modern agricultural research. In its earlier stages the investigation of the farmer's problems had been limited to the application of the physical and biological sciences to the production of crops and the breeding and feeding of live stock, and the setting up of the Institute in 1913 marks the realisation of the fact that the application of economics can also serve the rural community in many important ways. Not only is this necessary in the interests of the farmer and his man, but investigation is needed also of the larger question of the place of agriculture in national economy, and of the problem of the

directions in which development is possible in a country so highly industralized as Great Britain.

Summary of Work.

The work of the Institute falls under three principal heads :—

I. *Farm Management Studies.*

In the great majority of cases this class of work involves personal investigation amongst farmers and others engaged in the agricultural industry whose co-operation is vital to the conduct of such studies. Briefly the methods may be classified thus :

1. Cost accounting.
2. Financial accounting. } embracing the whole of the operations of the Farm.
3. Surveys,
   (i) directed to investigation of the whole business of the farm ; or
   (ii) dealing only with individual items of farm production or the cost of operating equipment, &c.

1. *Costing.*—At the present time twenty-two farms, ranging in size from 150 to 2,403 acres, covering a total area of 10,424 acres, are being fully costed. Much information of general value is being obtained from the cost data. For example, in operating expenses, it is found that horse labour varies from 3·4d. to 9·4d. per horse-hour. The lower costs are usually found when a high number of hours are worked per annum, but this is not universal, for quite low costs are sometimes found on grass farms where very little winter work is done and the horses are kept out of doors. This rather suggests that there is an *optimum* number of days of work and costs for different styles of farming.

In addition to full cost accounting a study by survey methods of the costs of growing sugar beet in the Advisory Province of Oxfordshire and Northamptonshire is going on, and reports are issued from time to time.

2. *Financial Accounts.*—The collection and examination of financial accounts from various farmers was first undertaken in 1925, and is being continued.

3. *The Survey.*—(i) General Surveys. The following general surveys have been carried out by the Institute :—

District.	Type of Farming.	No. of Farms.
1. Upper Thames Valley in Berkshire and Oxfordshire	Mixed	90
2. Oxfordshire (North)	Arable	172
3. Northamptonshire	Feeding and Dairying	
4. Oxfordshire (South)	Mixed	145
5. „ „	Mixed	119
6. Wiltshire	Dairying	200
7. Northamptonshire	Dairying	70 (Approximate).
8. Northamptonshire and Leicestershire	Feeding	80 (Approximate).
Total		876

It is not possible here to elaborate the information which has been collected from these surveys. The details are made available as the various reports are published.

(ii) Special Surveys.—(a) *Small Holdings.*—A study of the social and economic significance of the small unit of cultivation in a typical peasant district has just been completed and published.

(b) *Market Gardening in the Vale of Evesham.*—A special study is in progress of the origin, growth, and present development of the fruit growing and market gardening industry in the Vale of Evesham. In order to obtain accurate information a detailed study of the holdings in one typical parish was undertaken. Data have been collected as to the different crops grown and rotations practised, yields of crops, kinds and quantities of manures used, methods of marketing produce, number of men employed, rent, rates, &c., conditions of tenure, with special reference to the Evesham Custom, and any other facts likely to throw light upon the economic development of this industry. The survey is not yet complete.

(c) *Grade A (Tuberculin Tested) Milk.*—With invaluable assistance given by Reading University, the Institute has carried out an investigation of the economics of Grade A (T.T.) milk, and a report has been published by the Institute.

(d) *Sugar Beet.*—The Subsidy voted in Parliament in 1924 on sugar manufactured in Great Britain from home-grown beet, gave the necessary impetus to the growing of sugar beet in this country, and in view of the insistent demands made by farmers to be informed

of the prospect of sugar beet it became necessary to make a careful and unbiassed survey of the economics of the crop in its broadest aspects. In order to answer the questions of more immediate importance a cost of production study was inaugurated by the Institute in the autumn of 1924 to cover the operation of the 1924–5 crop, which was the first to receive the benefits of the subsidy, and the results of the study are embraced in the Research Monograph No. 3, published by the Ministry of Agriculture and Fisheries at the end of 1925. The work is being continued and extended.

(e) *Machinery in Agriculture.*—Another investigation now in progress is to determine how far the introduction of machinery is economical and the extent to which it can influence the efficiency and, in consequence, the standard of living of rural labour in Britain and in the United States respectively.

4. *The Maintenance of Arable Farming.*—A recent research undertaken by the Institute is directed towards the consideration of how to maintain the proportion of plough-land. Statistics show that the war-time accretions have been lost and the arable total is now below its previous low record. Everybody knows that plough-land employs more labour and yields a greater product than grass-land (except in some of the more favoured dairying districts), but it has still to be demonstrated that certain types of land can yield a profit under the plough in the prevailing economic conditions, and that farmers are not justified in playing for safety by laying land down to grass. Recent experimental work in the direction of live stock maintenance on arable crops instead of on grass, combined with the experience of farmers here and there who have had the courage to experiment for themselves, gives reason to hope that a departure from the traditional practice in the direction of using plough-land more for the growth of forage crops for stock, and less for corn crops, will show financial results which will justify the extension of the present arable area.

5. *The Operation of the Law of Diminishing Returns in Agriculture.*—Somewhat closely associated, in principle, with the foregoing investigation is another which is being undertaken to show in what precise way the "law" operates as regards agriculture, what quantitative interpretation can be given to it and, this done, what conclusions may then be drawn.

6. *The Marketing of Farm Products.*—Research in marketing problems was first undertaken in the beginning of 1925. It was felt that from the farmer's point of view it was clearly no less important to understand how to dispose satisfactorily of commodities than how to produce them in the first place.

Most farmers, investigators, and other persons interested entertain general ideas to the effect that there are too many middlemen, that the spread between producer and consumer is too great, and that farm produce lacks the consistency and standardisation which is essential to economic distribution, and they agree on certain general

remedies for these problems, chiefly by popularising the theory of co-operation. But there appeared to be a serious absence of precise information concerning the actual processes of agricultural marketing, without which it would obviously be unwise to endeavour to provide remedies. This pointed to the necessity for a detailed study of the subject from the farmer's point of view.

Three reports have been published so far, dealing with the Marketing of Meat, the Marketing of Milk and the Distribution of Milk in Somerset and Wiltshire.

7. *The Insurance of Farm Live Stock.*—In the Report of the *Agricultural Tribunal of Investigation* the need for statistical data concerning the incidence of live stock mortality in this country was emphasised. Such information is of primary importance if anything is to be attempted in the direction of the extension of live stock insurance, and practically nothing is available at present. On the other hand, much work has been done in Continental countries to investigate the facts, and the information collected has been utilised largely for the formulation of insurance schemes.

In pursuance of the suggestion made by the *Tribunal*, work was begun on the collection of data in 1924, and at the same time a study of Continental data, of which a great deal exists, was undertaken. Considerable progress has been made and a report is in preparation.

II. *Rural Life Studies.*

The Survey of Rural Industries.—From time to time the scope of the work of the Institute is extended to the consideration of problems outside the organisation of farming, as when a comprehensive survey of the rural industries of England and Wales was undertaken. The survey was recently completed, and for convenience of publication the reports have been collected together, in four volumes, as follows :

England.

Vol. I.—Timber and Underwood Industries and Some Village Workshops.

Vol. II.—Osier-growing, Basketry Industries and Some Rural Factories.

Vol. III.—Decorative Crafts and Rural Potteries.

Wales.

Vol. IV.—Rural Industries in Wales.

III. *Miscellaneous Studies.*

Miscellaneous studies are undertaken from time to time, largely by research scholars attached to the Institute. Those completed include an Agricultural Atlas of England and Wales, published by the Ordnance Survey Department.

IV.

Another branch of the work of the Institute has to do with the collection and dissemination of data concerning economics of agriculture within the Empire, with special reference to the technique and results of cost accounting and survey methods, an appointment having been made in January, 1928, with the aid of the Empire Marketing Board, for this particular object.

Facilities for Advanced Study and Research.

Facilities for advanced study and research can be provided at the Institute for post-graduate students having a standing which entitles them to read for the degrees of B.Litt., B.Sc., or D.Phil. in the University of Oxford, who are willing to join the University and undertake a course of work leading to one of the above research degrees.

F.—Preservation and Transport.

(40) LOW TEMPERATURE STATION FOR RESEARCH IN BIO-CHEMISTRY AND BIO-PHYSICS (DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH) (IN CONJUNCTION WITH THE UNIVERSITY OF CAMBRIDGE).

Railway Station: Cambridge (L.N.E.R.). *Telephone:* Cambridge 753. *Telegrams:* Lowtemp., Cambridge.

Staff.

Sir W. B. Hardy, M.A., LL.D., F.R.S. (*Director of Food Investigation*) (Superintendent); J. Barker, M.A., Ph.D.; J. M. Bryan, B.Sc.; E. H. Callow, B.Sc., Ph.D.; Franklin Kidd, M.A., D.Sc.; T. Moran, Ph.D.; T. N. Morris, M.A., Agric.Dip.; J. J. Piqué, A.M. (Ghent); A. J. M. Smith, M.A., Ph.D.; E. C. Smith, M.Sc., Ph.D.; R. G. Tomkins, B.A.; Cyril West, M.A., D.Sc.

Aims of the Station.

The aim of the Station is the investigation of the principles which determine the behaviour of food-products in their handling, transport, storage and preservation. The investigations range from *ad hoc* researches in the field of industry which appear likely to yield results of general significance, to laboratory researches indistinguishable from academical research except in the industrial nature of the material.

Equipment and Facilities of the Station.*

The Station has been in use since 1922. It is now being extended and the extension will be completed by the summer of 1929. The Station will then have a floor space of 28,000 square feet, of which 9,000 square feet will be laboratories. There will be, in all, thirty-one constant-temperature rooms ranging from −20°C. to +30°C. The output of the refrigerating plant will be 132,000 B.Th.U. per hour, working under the conditions required for the experiments. The Station is specially equipped for research of a biological character.

Summary of Work.

For convenience the work in progress is summarised under the following heads:—(I) plant problems, (II) animal problems, (III) fungal and bacteriological problems, (IV) canning problems, (V) biological engineering problems, and (VI) problems of the pig industry.

(I) *Plant Problems.*

(*a*) Cold storage investigations of fruit and vegetables with special reference to the influence upon storage life of (i) race, (ii) pre-storage conditions and (iii) conditions of storage.

(*b*) Gas-storage investigations of fruit and vegetables with special reference to the influence upon storage life of (i) race, (ii) pre-storage conditions and (iii) conditions of storage.

(*c*) Investigation of the physiological, chemical and physical changes in senescent plant organs.

(*d*) Functional diseases of fruit and vegetables in cold storage and gas storage.

(*e*) Preservation of fruit and vegetables by freezing.

(II) *Animal Problems.*

(*a*) The post mortem changes in muscle, including the changes in the carbohydrate, protein and water constituents.

(*b*) A general study of the freezing of tissues.

(*c*) The influence of external factors on the surface changes in muscle, including desiccation, pigment-changes and the growth of micro-organisms.

(*d*) The changes in animal fats during storage at various temperatures.

(*e*) The factors giving rise to spoilage in the preparation and storage of plant.

Viewed collectively these studies form the basis of the science of the preparation of meat and its preservation by freezing and chilling.

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* Space will not be available for outside workers until somewhere about the middle of 1929. The conditions of admission can be obtained from the Superintendent.

III. *Fungal and Bacteriological Problems.*

1. Problems of mycological interest arising during the experiments with fruit, meat and other perishable food products in the Station generally.

2. Examination of loss or damage in the Covent Garden Market and in the overseas transport of fruit, vegetables, etc. A small laboratory is maintained at Covent Garden and the investigations are carried out in two ways :—

(*a*) By an examination of general types of wastage. The interest here lies in the occurrence and specificity of fungi from a number of different countries. Up to the present particular attention has been paid to citrus fruits and pineapples.

(*b*) By a detailed examination of experimental shipments of a particular fruit from a particular country, *e.g.*, New Zealand apples. In this way precise data become available, not only of the number of fungi actually causing loss, but of the relative importance of each species. The results of these investigations should be suggestive of methods for controlling infection in the country of export.

3 A study of the dependence of the rate of growth and development of fungi on external factors, especially the humidity of the atmosphere.

IV. *Canning Problems.*

Investigations into the principles and problems involved in the preservation and storage of fruits, meat and vegetables by canning, bottling, jam-making and allied methods.

In canning, the investigation is chiefly directed to the factors affecting the corrosion of the metals of which containers may be made by fruit acids, acid syrups, and brines.

V. *Biological Engineering Problems.*

In the laboratory, the biophysical problems of the evaporation of water from stored biological material and of heat production of fruit and vegetables are being studied. In the field, surveys of the conditions of temperature and humidity in commercial stores variously operated and carrying various produce, and during railway and steamship transport, are being conducted with a view to a better control of conditions in bulk storage of " active " material.

VI. *Problems of the Pig Industry.*

A preliminary survey of the industry and its requirement has been made, and a tentative programme of research work has been drawn up. Work is in progress on the use of frozen pork for the manufacture of bacon and ham, and on the transport of frozen bacon. It is also proposed to study the fundamental science of salt curing.

G.—Agricultural Engineering.

41) INSTITUTE OF AGRICULTURAL ENGINEERING: UNIVERSITY OF OXFORD.

Address: 37A, St. Giles, Oxford. Railway Station: Oxford; *Telegrams:* Machinery Oxford; *Telephone:* Oxford 3166.

Staff.

Director	Brynar James Owen, M.A., M. Eng., D.Sc.
Mechanical Engineering	E. B. Black, B.Sc.
Agricultural Physics ..	J. H. Blackaby, B.Sc.
Electrical Engineering ..	C. A. C. Brown, B.Sc., A.M.I.E.E.
Agricultural Physics and Chemistry.	W. H. Cashmore, B.A., N.D.A.

Aims of the Institute.

This Institute was established in April, 1924, by the Ministry of Agriculture and Fisheries, to continue and extend the work in agricultural engineering conducted previously by the Machinery Section of the Ministry.

Its object is to undertake research into all departments of agricultural engineering, including the supply and application of power to agriculture, the use and possible improvement of field implements and of the stationary machines of the farm and the development of new mechanical methods and appliances; it also studies problems connected with land improvement, with special reference to drainage and drainage machinery; and it is interested in the application of methods of drying suitable for operation on the farm, for the better preservation of agricultural products. Though the teaching side of its work has not as yet been much developed, the provision of instruction in agricultural engineering is also part of its programme. It is also called upon to assist in the testing of agricultural machinery under the Ministry of Agriculture's testing scheme, inaugurated in 1926. Apart from these official tests, it conducts trials and demonstrations. It is also prepared to answer enquiries relating to agricultural engineering of which a large number is received not only from Great Britain but from other parts of the Empire.

Summary of Work.

The main subjects of research hitherto studied at the Institute have been (*a*) The artificial drying of crops in the stack, (*b*) the generation of electricity by wind-power, (*c*) the value of sub-soiling and (*d*) the extraction of sugar from sugar-beet by the desiccation

process. To these have lately been added (*e*) the use of electricity on the farm and (*f*) field drainage. Of these the first three were originally undertaken by the Ministry of Agriculture.

Investigations in progress or projected include the generation of electricity for farm use from small water supplies; the use of electricity for cultural operations; comparative trials of tillage machinery, including rotary tillage; machinery for the cultivation and harvesting of sugar beet; potato harvesting machinery; the applicability of the combined harvester and thrasher to English conditions and the design in this connection of portable grain dryers.

(*a*) *The Artificial Drying of Crops in the Stack.*—In the first series of trials, undertaken by the Ministry of Agriculture, the apparatus was confined to a power-driven fan, by which air at atmospheric temperature was forced into a central chamber round which the stack had been built. This process proved too slow and unreliable. In the next series (1924) of experiments, conducted by the Institute, a method of heating the ingoing air was used. The air was drawn through a closed tank, with flues heated by oil burners, in such a way that the air was frequently brought into contact with the heat radiated from the flues. The heat was originally obtained from high pressure paraffin burners, but better and cheaper results were subsequently obtained from a low pressure system using fuel oil. In the heater as now designed the flues are dispensed with and the air warmed by passing it over heated plates. The use of coke as an alternative for oil is being considered. Permanent installations, employing steam coils inside the stack, on the principle already adopted by other workers, are being investigated.

(*b*) *The Generation of Electricity by Wind-Power.*—Investigations were, in 1925, carried out by the Institute on seven different mills representing the multi-bladed, stream-line and semi-stream-line types. The cost per unit of electricity varied from 4d. to 12·7d. Rather more than half of the cost is due to the necessity of having a battery for storage to tide over periods of calm and also to steady the power supply, which would otherwise rise and fall with the wind. To eliminate the battery altogether would be impossible but by exercising care, or by having a subsidiary source of power in reserve, the size of the battery might be reduced. It is not suggested that wind-mill generated electricity should be preferred to public supply where such is available, but it should be of distinct use in remote districts, especially those of high altitude or near the coast, where more continuous wind can be relied on.

(*c*) *Sub-soiling.*—The process of sub-soiling aims at breaking up and loosening the soil below the depth ordinarily reached by ploughing, without bringing that soil to the surface. A trial of sub-soiling implements was held in October, 1922, in Kent and in the winter and spring of 1922–23 plots on various types of soil were laid down in Essex. All these plots were ploughed to a uniform

depth of 5 inches, and of these certain were sub-soiled to further depths of 5, 7 and 9 inches, the extra cost of sub-soiling varying according to soil and depth up to 13s. 11d. per acre. In subsequent years the plots were again ploughed but not again sub-soiled. The results obtained have been strikingly in favour of sub-soiling, especially with potatoes and roots. The extra yields obtained on the sub-soiled plots have not only paid the cost of the one sub-soiling, but have left a wide margin of profit ; the fact that in the fourth year after sub-soiling the increase of yield on the sub-soiled plots was still considerable is evidence of the permanency of the effect of the one operation.

(*d*) *Sugar Beet.*—During 1924 the attention of the Ministry of Agriculture was directed to a process for the extraction of sugar from previously dried beets which was being worked in Italy. A Commission, appointed to visit Italy and examine the process, in the course of a report issued in February, 1925, recommended the installation of an experimental plant and the undertaking of experiments with the view of devising a complete equipment, of capacity suitable for operation by the beet grower, for cleaning, slicing and drying. The dried beet would cost considerably less to transport to the central extraction factory and, as it would keep indefinitely, the extraction process could be carried on over a whole year instead of being confined to less than a third of the year, thus considerably reducing the cost of factory erection and regularising labour requirements.

A grant made by the Ministry of Agriculture permitted research on a laboratory scale to be begun in 1925. Early in 1926 an experimental factory was opened at Eynsham, near Oxford, in which the whole process of drying and the subsequent processes of extraction, purification and crystallisation were thoroughly studied. The methods finally evolved, differing in certain essential particulars from those adopted by previous investigators in the same field, have during the season 1927–1928 been worked on a commercial scale by a private company on the site of the original experimental factory at Eynsham with encouraging results, and the provision of local drying stations is being considered.

(*e*) *Electricity on the Farm.*—An investigation into the use made of electricity on the farm as exemplified by electrically equipped farms in the Chester area has been completed. The object of this work was to obtain some definite information as to the demands likely to be made by rural districts. Figures have been obtained showing the power demands and cost of the individual barn-yard operations and the distribution of the load between domestic and farm uses, and it is hoped that these figures will serve as a reliable basis for estimating the probable and possible requirements of farms and rural districts generally.

(*f*) *Field Drainage.*—The working of various types of mole-ploughs has been observed. In view of the growing popularity of this type of drainage and the tendency to use tractor-drawn machines, cutting shallower drains, it is proposed to watch the effectiveness of these drains, their permanence and resistance to overhead pressure.

(*g*) *Other Projects.*—Of investigations in progress mention may be made of those concerning machinery for the cultivation and harvesting of sugar beet and the applicability of the combine harvester-thrasher to English conditions. As regards the former the substitution of efficient machinery in every possible operation is called for owing both to the cost and to the difficulty of obtaining manual labour. The latter question is to be studied by the use of an imported machine during the 1928 harvest. The argument usually advanced against its use in this country is that our grain at the time of harvesting is too moist. Investigations of standing grain during 1927 showed that moisture content was not too great to allow of the grain being harvested by the combine, though for storing it would probably need to be artificially dried. Accordingly the question of grain drying is also being considered and a dryer and cleaner has been designed for use with the combine.

II.

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BACTERIOLOGY.

DURHAM, College of Medicine	H. J. Hutchens, D.S.O., D.P.H., M.A.
LEEDS	J. W. McLeod, O.B.E., M.B., Ch.B.
LIVERPOOL	J. M. Beattie, M.A., M.D., C.M.
LONDON.	
London Hospital Medical College.	W. Bulloch, M.D., C.M., LL.D., F.R.S.
London School of Hygiene and Tropical Medicine.	W. W. C. Topley, M.A., M.D., B.Ch., M.R.C.S., F.R.C.P. (*and Immunology*).
Guy's Hospital Medical School.	J. W. H. Eyre, M.D., M.S., D.P.H.
St. Thomas's Hospital Medical School.	L. S. Dudgeon, C.M.G., C.B.E., F.R.C.P.
Lister Institute of Preventive Medicine.	J. C. G. Ledingham, C.M.G., D.Sc., F.R.S.
Royal Veterinary College..	Tom Hare, M.D., B.Ch., B.V.Sc., M.R.C.V.S.
MANCHESTER	H. B. Maitland, M.D., M.R.C.S., L.R.C.P.
READING	R. Stenhouse Williams, M.B., D.P.H., D.Sc.
NOTTINGHAM, University College.	H. S. Holden, D.Sc., F.R.S.E., F.L.S.
WALES..	J. H. Dible, M.B., Ch.B.
ABERDEEN	J. Cruickshank, M.D., D.Sc.
EDINBURGH	T. J. Mackie, M.D.
GLASGOW	C. H. Browning, M.D., D.P.H.
Royal Technical College ..	D. Ellis, D.Sc., Ph.D.
ST. ANDREW	W. J. Tulloch, O.B.E., M.D., D.P.H.

BOTANY.

BIRMINGHAM	R. H. Yapp, M.Sc., M.A.
BRISTOL	O. V. Darbishire, B.A., Ph.D., F.L.S. B. T. P. Barker, M.A. (*Agricultural*).
CAMBRIDGE	A. C. Seward, Sc.D., F.L.S., F.R.S. Sir Rowland H. Biffen, M.A. (*Agricultural*). R. C. Punnett, M.A., F.R.S. (*Plant Genetics and Small Animal Breeding*).
DURHAM, Armstrong College, Newcastle-on-Tyne.	J. W. H. Harrison, D.Sc., F.R.S.
LEEDS	J. H. Priestley, D.S.O., B.Sc., F.L.S.
LIVERPOOL	J. McLean Thompson, M.A., D.Sc., F.L.S. C. E. Walker, D.Sc., M.R.C.S., L.R.C.P. (*Cytology*).
LONDON.	
University College ..	F. W. Oliver, M.A., D.Sc., LL.D., F.L.S., F.R.S.
King's College	R. Ruggles Gates, M.A., B.Sc., Ph.D., LL.D., F.L.S.

Imperial College of Science and Technology.	Sir J. B. Farmer, M.A., D.Sc., LL.D., F.L.S., F.R.S. V. H. Blackman, M.A., Sc.D., F.L.S., F.R.S. (*Plant Physiology*). P. Groom, M.B.E., M.A., D.Sc., F.L.S., F.R.S. (*Technology of Woods and Fibres*).
East London College ..	F. E. Fritch, D.Sc., Ph.D., F.L.S.
Birkbeck College	Dame Helen Gwynne-Vaughan, D.B.L., LL.D., D.Sc., F.L.S.
South-Eastern Agricultural College, Wye, Kent.	E. S. Salmon, F.L.S. (*Mycology*).
Bedford College for Women	W. Neilsen Jones, F.L.S.
Royal Veterinary College..	T. J. Evans, M.A.
MANCHESTER	F. E. Weiss, D.Sc., M.A., F.L.S., F.R.S. W. H. Lang, M.B., C.M., D.Sc., F.L.S., F.R.S. (*Cryptogamic*).
OXFORD	A. G. Tansley, M.A., F.L.S., F.R.S.
READING	W. Stiles, M.A., Sc.D., F.R.S., F.L.S J. Percival, M.A., Sc.D., F.L.S. (*Agricultural*).
EXETER, University College of the South-West of England.	J. L. Sager, M.A.
NOTTINGHAM, University College.	H. S. Holden, D.Sc., F.R.S.E., F.L.S.
UNIVERSITY COLLEGE OF SOUTHAMPTON.	S. Mangham, M.A.
WALES.	
University College of Wales, Aberystwyth.	R. G. Stapledon, M.A. (*Agricultural*). Wilfrid Robinson, D.Sc., F.L.S.
University College of North Wales, Bangor.	D. Thoday, M.A.
University College of South Wales, Cardiff.	R. C. McLean, M.A., D.Sc., F.L.S.
ABERDEEN	W. G. Craib, M.A., F.L.S.
EDINBURGH	Wm. Wright Smith, M.A., F.R.S.E.
GLASGOW	J. Montagu F. Drummond, M.A., F.L.S.
BELFAST, Queen's University	S. P. Mercer, B.Sc. (*Agricultural*). J. Small, D.Sc., M.R.I.A., F.R.S.E., F.L.S.

ZOOLOGY.

BIRMINGHAM	H. Munro Fox, M.A.
CAMBRIDGE	J. S. Gardiner, M.A., F.R.S. F.L.S. G. H. F. Nuttall, Sc.D. (*Parasitology*).
DURHAM, Armstrong College, Newcastle-on-Tyne.	A. Meek, D.Sc., F.Z.S.
LEEDS	W. Garstang, M.A., D.Sc., F.L.S.
LIVERPOOL	W. J. Dakin, D.Sc., F.Z.S., F.L.S. W. S. Patton, M.B., Ch.B. (*Entomology*). W. Yorke, M.D. (*Parasitology*).

LONDON.	
University College ..	D. M. A. Watson, M.Sc., F.R.S.
King's College	Doris L. MacKinnon, D.Sc., F.L.S.
Imperial College of Science and Technology.	E. W. MacBride, M.A., D.Sc., LL.D., F.R.S., F.L.S.
	F. Balfour-Browne, M.A. (*Entomology*).
Birkbeck College	H. G. Jackson, D.Sc., F.Z.S.
Bedford College for Women	C. L. Boulenjer, M.A., D.Sc., F.Z.S.
London School of Hygiene and Tropical Medicine.	R. T. Leiper, D.Sc., M.D., Ch.B., F.R.S. (*Helminthology*).
Royal Veterinary College	T. J. Evans, M.A.
MANCHESTER	J. S. Dunkerley, D.Sc., Ph.D.
OXFORD	E. S. Goodrich, M.A., D.Sc., F.R.S., F.L.S.
	E. B. Poulton, M.A., D.Sc., LL.D., F.R.S., F.L.S., F.G.S., F.Z.S., F.E.S.
READING	F. J. Cole, D.Sc., F.R.S.
SHEFFIELD	H. G. Cannon, M.A., D.Sc., F.L.S., F.R.S.E.
EXETER, University College of the South-West of England.	Geoffrey Le Page, M.Sc., M.B., Ch.B. (*Agricultural*).
NOTTINGHAM, University College.	H. Lister, B.Sc., F.Z.S.
UNIVERSITY COLLEGE OF SOUTHAMPTON.	W. R. Sherriffs, M.A., D.Sc., F.L.S.
WALES.	
University College of Wales, Aberystwyth.	R. D. Laurie, M.A.
University College of North Wales, Bangor.	P. J. White, M.B.
University College of South Wales, Cardiff.	W. M. Tattersall, D.Sc.
ABERDEEN	J. Arthur Thomson, M.A., LL.D.
EDINBURGH	J. H. Ashworth, D.Sc., F.R.S.
GLASGOW	J. Graham Kerr, M.A., F.R.S., F.L.S., F.Z.S.
ST. ANDREWS UNIVERSITY (St. Andrews, Dundee).	D. A. W. Thompson, C.B., M.A., D.Litt., F.R.S.
	A. D. Peacock, D.Sc., F.R.S.E.
BELFAST, Queen's University	G. Wilson, O.B.E., M.A., D.Sc., Ph.D.

PHYSIOLOGY.

BIRMINGHAM	I. de Burgh Daly, M.A., M.D.
BRISTOL	G. A. Buckmaster, M.A., B.Ch., D.P.H.
CAMBRIDGE	J. Barcroft, C.B.E., M.A., F.R.S.
DURHAM, College of Medicine	D. Burns, M.A., D.Sc.
LEEDS	B. A. McSwiney, B.A., M.B., Ch.B.
LIVERPOOL	J. S. Macdonald, M.A., F.R.S.
LONDON.	
University College ..	C. A. Lovatt Evans, D.Sc., M.R.C.S., L.R.C.P., F.R.S.
	A. V. Hill, O.B.E., M.A., Sc.D., F.R.S.
King's College	R. J. S. McDowell, D.Sc., M.B., Ch.B., M.R.C.P., V. H. Mottram.

Bedford College for Women	J. S. Edkins, M.A., M.B., Sc.D.
St. Mary's Hospital Medical School.	B. J. Collingwood, O.B.E., B.A., M.D., B.Ch.
St. Bartholemew's Hospital Medical College.	H. Hartridge, M.A., M.D., B.Ch., Sc.D., F.R.S.
St. Thomas's Hospital Medical School.	J. Mellanby, M.A., M.D.
Guy's Hospital Medical School.	M. S. Pembrey, M.A., M.D., B.Ch., F.R.S.
London Hospital Medical College.	H. E. Roaf, M.D., D.Sc.
Middlesex Hospital Medical School.	S. Vincent, D.Sc., M.D.
London (R.F.H.) School of Medicine for Women.	Winifred C. Cullis, O.B.E., D.Sc.
Royal Veterinary College..	W. Legge Symes, M.A.C.S.
MANCHESTER	H. S. Raper, C.B.E., D.Sc., M.B., Ch.B.
OXFORD	Sir Charles S. Sherrington, O.M., G.B.E., M.A., Hon. D.Sc., F.R.S.
SHEFFIELD	J. B. Leathes, M.A., M.B., B.Ch., F.R.C.S., F.R.C.P., F.R.S.
WALES.	
University College of South Wales, Cardiff.	T. Graham Brown, M.D., D.Sc., F.R.S.
ABERDEEN	J. R. R. MacLeod, D.Sc., LL.D., M.B., Ch.B., F.R.S.
EDINBURGH	Sir E. A. Sharpey Schafer, LL.D., F.R.S.
GLASGOW	E. P. Cathcart, C.B.E., M.D., D.Sc., LL.D., F.R.S.
ST. ANDREWS UNIVERSITY (St. Andrews, Dundee)	P. T. Herring, M.D. E. Waymouth Reid, B.A., M.B., F.R.S.
BELFAST, Queen's University	T. H. Milroy, M.D., B.Sc.

ANATOMY.

BIRMINGHAM	J. C. Brash, M.A., M.D., Ch.B., B.Sc.
BRISTOL	E. Fawcett, M.D., C.M., F.R.S.
CAMBRIDGE	J. T. Wilson, M.A.
DURHAM, College of Medicine, Newcastle-on-Tyne.	R. G. Green, M.A., M.B., B.S., F.R.C.S.
LEEDS	J. Kay Jamieson, M.B., C.M.
LIVERPOOL	W. H. Wood, B.Sc., M.D.
LONDON.	
University College ..	G. Elliot Smith, M.A., Litt.D., M.D., Ch.M., D.Sc., F.R.S., F.R.C.P.
King's College	D. MacCallum Blair, M.B., Ch.B.
St. Bartholemew's Hospital Medical College.	W. E. Le G. Clark, F.R.C.S., L.R.C.P.
St. Mary's Hospital Medical School.	J. E. S. Frazer, F.R.C.S., L.R.C.P.
Guy's Hospital Medical School.	T. B. Johnston, M.B., Ch.B. G. W. de P. Nicholson, M.A., Ph.D.
London (R.F.H.) School of Medicine for Women.	Mrs. M. F. L. Keene, M.B., B.S.

London Hospital Medical College.	W. Wright, D.Sc., M.B., Ch.B., F.R.C.S., L.R.C.S.
	H.M. Turnbull, M.A., B.Ch., D.M., M.R.C.P., M.R.C.S. (*morbid*).
St. Thomas's Hospital Medical School.	F. G. Parsons, F.R.C.S., L.R.C.P.
Middlesex Hospital Medical School.	T. Yeates, M.B., C.M., B.Hy., D.P.H.
Royal Veterinary College..	J. McCunn, M.R.C.S., L.R.C.P., M.R.C.V.S.
MANCHESTER	J. S. B. Stopford, M.D.
OXFORD	A. Thomson, M.A.
	E. S. Goodrich, M.A., D.Sc. (*comparative*).
	E. B. Poulton, M.A., D.Sc. (*comparative*).
SHEFFIELD	C. J. Patten, M.A., M.D., Sc.D., F.R.A.I.
WALES.	
University College of South Wales.	C. McLaren West, M.C., M.B., B.A.O., B.Ch., Sc.D.
ABERDEEN	Alex. Low, M.A., M.D.
EDINBURGH	A. Robinson, M.D.
GLASGOW	T. H. Bryce, M.A., M.D., F.R.S.
EDINBURGH	A. Robinson, M.D.
ST. ANDREWS UNIVERSITY (St. Andrews, Dundee).	D. Waterston, M.A., M.D., C.M.
	D. R. Dow, M.D., Ch.B., D.P.H.
BELFAST, Queen's University	T. Walmsley, M.D.

PATHOLOGY.

BIRMINGHAM	G. H. Wilson, M.D.
BRISTOL	I. Walker Hall, M.D., Ch.B.
CAMBRIDGE	J. B. Buxton, M.A. (*Animal*).
	H. R. Dean, M.D.
DURHAM	S. McDonald, M.A., M.D.
LEEDS	M. J. Stewart, M.B., Ch.B., F.R.C.P.
	R. D. Passey, M.C., M.D., B.S., D.P.H.
LIVERPOOL	E. E. Glynn, M.A., M.D., C.M., F.R.C.P.
School of Veterinary Science	S. H. Gaiger, F.R.C.V.S. (*Veterinary Science*).
	J. Share-Jones, D.V.Sc., M.Sc., F.R.C.V.S. (*Veterinary Science*).
LONDON.	
Lister Institute	Sir Charles J. Martin, C.M.G., D.Sc., M.B., F.R.S. (*Experimental*).
University College Hospital Medical School.	A. E. Boycott, M.A., B.Sc., D.M., B.Ch., F.R.S.
St. Bartholomew's Hospital Medical College.	E. H. Kettle, M.D., B.S., M.R.C.P.
Middlesex Hospital Medical School.	J. McIntosh, M.D., Ch.B.
Guy's Hospital Medical School.	R. Donaldson, M.A., M.D., Ch.B., F.R.C.S., D.P.H.
St. Thomas's Hospital Medical School.	L. S. Dudgeon, C.M.G., C.B.E., F.R.C.P.

St. Mary's Hospital Medical School.	Sir A. E. Wright, K.B.E., C.B., M.D., B.Ch., Sc.D., LL.D., B.A., F.R.S. (*Experimental*).
London (R.F.H.) School of Medicine for Women.	G. Hadfield, M.D., B.S., M.R.C.P.
Royal Veterinary College..	Tom Hare, M.D., B.Ch., B.V.Sc., M.R.C.V.S.
MANCHESTER	J. S. Dunn, M.A., M.D.
OXFORD	G. Dreyer, C.B.E., M.A., F.R.S.
SHEFFIELD	J. S. C. Douglas, M.A., D.M., B.Ch., M.Sc.
WALES..	J. W. Dible, M.B., Ch.B.
ABERDEEN	T. Shennon, M.D.
EDINBURGH	J. Lorrain Smith, M.A., M.D., LL.D., F.R.S.
GLASGOW	R. Muir, M.A., M.D., Sc.D., F.R.S.
ST. ANDREWS	L. R. Sutherland, M.B., C.M.
BELFAST, Queen's University	W. St. E. Symmers, M.B.

CHEMISTRY.

BIRMINGHAM	W. N. Haworth, D.Sc., Ph.D.
BRISTOL	F. Francis, D.Sc., Ph.D., F.I.C.
CAMBRIDGE	Sir Wm. J. Pope, K.B.E., M.A., F.R.S.
DURHAM.	
College of Medicine and Armstrong College, Newcastle-on-Tyne.	J. I. Orme Masson, D.Sc., F.I.C. H. V. A. Briscoe, D.Sc., A.R.C.Sc., D.I.C. (*Inorganic and physical*).
Armstrong College Newcastle-on-Tyne.	G. R. Clemo, D.Sc., Ph.D., F.I.C. (*Organic*).
LEEDS	N. M. Comber, D.Sc., A.R.C.S., F.I.C. (*Agricultural*). R. W. Whytlaw-Gray, O.B.E., Ph. D., F.I.C. C. K. Ingold, D.Sc., A.R.C.S., D.I.C., F.I.C., F.R.S. (*Organic*).
LIVERPOOL	I. M. Heilbron, D.Sc., Ph. D., F.I.C. (*Organic*). E. C. C. Baly, C.B.E., M.Sc., F.R.S. (*Inorganic*).
LONDON.	
University College ..	F. G. Donnan, C.B.E., M.A., D.Sc., F.R.S. R. Robinson, D.Sc., F.R.S.
King's College	S. Smiles, O.B.E., D.Sc., F.R.S., F.I.C. A. J. Allmand, M.C., D.Sc., F.I.C. C. K. Tinkler, D.Sc., F.I.C.
Imperial College of Science and Technology.	J. F. Thorpe, C.B.E., D.Sc., Ph.D., F.R.S. (*Organic*). H. B. Baker, C.B.E., M.A., D.Sc., F.R.S.
East London College ..	J. R. Partington, M.B.E., D.Sc.
Bedford College for Women	J. F. Spencer, D.Sc., Ph.D., F.I.C. (*Inorganic and Physical*).
Royal Holloway College for Women.	T. S. Moore, M.A.
Guy's Hospital Medical School.	C. S. Gibson, O.B.E., M.A., M.Sc., F.I.C.

St. Thomas's Hospital Medical School.	R. H. A. Plimmer, D.Sc.
Middlesex Hospital Medical School.	W. B. Tuck, D.Sc.
Royal Veterinary College..	G. W. Clough, D.Sc.
MANCHESTER	A. Lapworth, D.Sc., LL.D., F.R.S.
OXFORD	W. H. Perkin, M.A., F.R.S. F. Soddy, M.A.
READING	H. Bassett, D.Sc., Ph.D., F.I.C. H. A. D. Neville, M.A., B.Sc., F.I.C. (*Agricultural*).
SHEFFIELD	W. P. Wynne, D.Sc., F.R.S., F.I.C.
EXETER—UNIVERSITY COLLEGE OF THE SOUTH-WEST OF ENGLAND.	W. H. Lewis, M.A., F.I.C.
UNIVERSITY COLLEGE OF NOTTINGHAM.	F. S. Kipping, Ph.D., D.Sc., F.I.C., F.R.S.
UNIVERSITY COLLEGE OF SOUTHAMPTON.	D. R. Boyd, D.Sc., Ph.D.. F.I.C.
WALES.	
University College of Wales, Aberystwyth.	T. C. James, M.A., D.Sc., F.I.C.
University College of North Wales, Bangor.	G. W. Robinson, M.A. (*Agricultural*). K. J. P. Orton, M.A., Ph.D., F.R.S., F.I.C.
University College of South Wales, Cardiff.	W. J. Jones, D.Sc., F.I.C., F.Inst.P.
University College of Swansea.	J. E. Coates, O.B.E., D.Sc., F.I.C.
ABERDEEN	Alexander Findlay, M.A., D.Sc., Ph.D.
EDINBURGH	J. P. Kendall, M.A., D.Sc.
GLASGOW	G. G. Henderson, D.Sc., F.R.S. T. S. Patterson, D.Sc., Ph.D. (*Organic*).
Royal Technical College ..	T. Gray, D.Sc., LL.D., Ph.D., F.I.C. F. J. Wilson, D.Sc., Ph.D., F.I.C. (*Organic*). R. M. Caven, D.Sc., F.I.C. (*Inorganic*).
ST. ANDREW'S UNIVERSITY (St. Andrews, Dundee).	J. Read, M.A., B.Sc., Ph.D.
BELFAST, Queen's University	A. McKenzie, M.A., Ph.D., D.Sc., F.R.S. (*Agricultural*). A. W. Stewart, D.Sc.

Bio-Chemistry.

CAMBRIDGE	Sir F. G. Hopkins, M.A., F.R.S.
DURHAM, College of Medicine	D. Burns, M.A., D.Sc.
LIVERPOOL	W. Ramsden, M.A., D.M.
LONDON.	
University College ..	J. C. Drummond, D.Sc., F.I.C.
Imperial College of Science and Technology.	S. B. Schryver, Ph.D., D.Sc., F.R.S.
Middlesex Hospital Medical School.	E. C. Dodds, M.D., B.S., B.Sc., M.R.C.S., L.R.C.P.
London School of Hygiene and Tropical Medicine.	P. Hartley, D.Sc.
Lister Institute	A. Harden, D.Sc., Ph.D., F.R.S.

Oxford	R. A. Peters, M.A.
Aberdeen	J. J. R. MacLeod, D.Sc., LL.D., M.B., Ch.B., F.R.S.
Edinburgh	George Barger, M.A., D.Sc., F.R.S.
Glasgow	Andrew Hunter, M.A., B.Sc., M.B. (*Physiological Chemistry*).
Belfast, Queen's University	J. A. Milray, M.A., M.D.

Physical Chemistry.

Bristol	W. E. Garner, M.A., D.Sc.
Cambridge	T. M. Lowry, C.B.E., M.A., F.R.S.
Durham, Armstrong College, Newcastle-on-Tyne.	H. V. A. Briscoe, D.Sc., A.R.C.Sc., D.I.C.
Leeds	H. M. Dawson, B.Sc., D.Sc., Ph.D.
Liverpool	W. C. McC. Lewis, M.A., D.Sc., F.R.S., F.Inst.P.
London, Imperial College of Science and Technology.	J. C. Philip, O.B.E., M.A., D.Sc., Ph.D., F.R.S.

Industrial Chemistry.

Birmingham	A. R. Ling, M.Sc., F.I.C. (*Brewing*).
Leeds	D. McCandlish, M.Sc. (*Leather Industries*). A. F. Barker, M.Sc. (*Textile Industries*).
Liverpool	T. P. Hilditch, D.Sc.
Manchester, College of Technology.	J. Kenner, Ph.D., D.Sc., F.R.S. (*Technological Chemistry*). W. E. Morton, M.Sc., Tech. (*Textile Technology*).
University College of Nottingham.	S. R. Trotman, M.A., F.I.C. (*Textiles*).
Belfast, Queen's University	H. Wren, D.Sc., Ph.D. (*Chemical Technology*).

PHYSICS.

Birmingham	S. W. J. Smith, M.A., D.Sc., A.R.C.S., F.R.S.
Bristol	A. M. Tyndall, D.Sc. J. E. Lennard-Jones, D.Sc., Ph.D. (*Theoretical*).
Cambridge	Sir Ernest Rutherford, O.M., M.A., Hon. Sc.D., F.R.S. (*Experimental*). Sir J. J. Thomson, O.M., M.A., Hon. Sc.D., F.R.S. F. J. M. Stratton, M.A., D.S.O. (*Astro-physics*).
Durham	J. E. P. Wagstaff, M.A., D.Sc.
Armstrong College, Newcastle-on-Tyne.	W. E. Curtis, D.Sc., A.R.C.Sc., F.R.A.S. G. W. Todd, M.A., D.Sc., F.Inst.P., F.P.S.L. (*Experimental Physics.*)
College of Medicine, Newcastle-on-Tyne.	D. Burns, M.A., D.Sc. (*Bio-physics*).
Leeds	R. Whiddington, M.A., D.Sc., F.R.S.
Liverpool	L. R. Wilberforce, M.A.

LONDON.	
University College ..	E. N. da C. Andrade, D.Sc., Ph.D.
King's College	E. V. Appleton, M.A., D.Sc., F.R.S.
	O. W. Richardson, M.A., D.Sc., F.R.S.
Imperial College of Science and Technology.	H. L. Callendar, C.B.E., M.A., LL.D., F.R.S.
	A. O. Rankine, O.B.E., D.Sc.
	A. Fowler, A.R.C.S., F.R.S. (*Astro-physics*).
	Sir Gilbert T. Walker, C.S.I., M.A., Sc.D., Ph.D., F.R.S. (*Meteorology*).
East London College ..	C. H. Lees, D.Sc., F.R.S.
Birkbeck College	A. Griffiths, D.Sc., A.R.C.S.
Bedford College for Women	W. Wilson, D.Sc., Ph.D., F.R.S.
Royal Holloway College for Women.	F. Horton, D.Sc., Sc.D., F.R.S.
St. Bartholomew's Hospital Medical College.	F. L. Hopwood, D.Sc.
Middlesex Hospital Medical School.	S. Russ, D.Sc.
MANCHESTER	W. L. Bragg, M.A., F.R.S.
OXFORD	J. S. E. Townsend, M.A.
READING	J. A. Crowther, M.A., Sc.D., F.Inst.P.
SHEFFIELD	S. R. Milner, D.Sc., F.R.S.; F.I.P.
UNIVERSITY COLLEGE OF THE SOUTH-WEST OF ENGLAND, EXETER.	F. H. Newman, D.Sc., A.R.C.Sc.
UNIVERSITY COLLEGE OF NOTTINGHAM.	P. E. Shaw, M.A., D.Sc.
UNIVERSITY COLLEGE OF SOUTHAMPTON.	H. Stansfield, D.Sc.
WALES.	
University College of Wales, Aberystwyth.	Gwilym Owen, M.A., D.Sc.
	D. Morgan Lewis, M.A.
University College of North Wales, Bangor.	E. A. Owen, M.A., D.Sc., F.Inst.P.
University College of South Wales, Cardiff.	H. R. Robinson, D.Sc., Ph.D., F.R.S.
University College of Swansea.	E. J. Evans, D.Sc., A.R.C.S.
ABERDEEN	George P. Thomson, M.A.
GLASGOW	J. G. Gray, D.Sc.
ST. ANDREWS UNIVERSITY (St. Andrews, Dundee).	W. Peddie, D.Sc.
	H. Stanley Allen, M.A., D.Sc., F.Inst.P.
BELFAST, Queen's University	W. B. Morton, M.A.

NATURAL PHILOSOPHY.

CAMBRIDGE	C. T. R. Wilson, M.A.
OXFORD	A. E. H. Love, M.A., D.Sc.
ABERDEEN	G. P. Thomson, M.A.
EDINBURGH	C. G. Barkla, M.A., D.Sc., F.R.S.
	C. G. Darwin, M.A., F.R.S.
GLASGOW, Royal Technical College.	E. Taylor Jones, D.Sc.
	J. Muir, M.A., D.Sc.
ST. ANDREWS .. .	H. Stanley Allen, M.A., D.Sc.

ENGINEERING.

CAMBRIDGE	C. E. Inglis, O.B.E., M.A. B. Melville Jones, M.A. (*Aeronautical*).
OXFORD	C. F. Jenkin, C.B.E., M.A.
MANCHESTER	A. H. Gibson, D.Sc., M.I.C.E., M.I.Mech.E.
UNIVERSITY COLLEGE OF NOTTINGHAM.	C. H. Bulleid, O.B.E., M.A., A.M.I.C.E., M.I.Mech.E.
WALES.	
University College of South Wales, Cardiff.	W, Norman Thomas, M,A., D.Phil, M.Sc.
University College of Swansea.	F. Bacon, M.A., A.M.I.C.E., M.I.M.E., M.I.E.
ABERDEEN	W. Blackadder, D.Sc., A.M.I.C.E.
EDINBURGH	Sir Thomas Hudson Beare, B.A., B.Sc., M.I.E. C. G. Barkla, M.A., D.Sc., F.R.S. C. G. Darwin, M.A., F.R.S.

Civil Engineering.

BIRMINGHAM	C. Batho, D.Sc., B.Eng.
BRISTOL	A. J. S. Pippard, M.B.E., D.Sc.
DURHAM, Armstrong College, Newcastle-on-Tyne.	C. J. Hawkes, M.Sc., A.M.I.C.E., M.I.N.A., M.I.Mech.E.
LEEDS	W. T. David, M.A., Sc.D., M.I.C.E., M.I.Mech.E.
LIVERPOOL	S. W. Perrott, M.A.I., M.I.C.E.
LONDON.	
University College ..	E. G. Coker, M.A., D.Sc., F.R.S., M.Inst.C.E. M. T. M. Ormsby, F.R.G.Sc. (*Municipal*). W. E. Gibbs, D.Sc. (*Chemical*).
King's College	A. H. Jameson, M.Sc., M.I.C.E.
Imperial College of Science and Technology.	S. M. Dixon, M.A., M.Sc., B.A.I., M.I.C.E.
East London College ..	E. H. Lamb, D.S.C., M.Sc., M.I.M.E., A.M.I.C.E.
SHEFFIELD	Joseph Husband, M.Eng., M.I.C.E., F.R.C.Sc.I., M.Am.Soc.C.E., M. French Soc.C.E., M.I.Struct.E.
UNIVERSITY COLLEGE OF SOUTHAMPTON.	J. Eustice, B.Sc., A.R.S.M., A.M.I.C.E.
GLASGOW, Royal Technical College.	J. D. Cormack, C.M.G., C.B.E., D.Sc. G. Moncur, B.Sc., M.I.C.E.
ST. ANDREW'S	A. R. Fulton, D.Sc.
BELFAST, Queen's University	F. H. Hummel, M.Sc., A.M.I.C.E.

Electrical Engineering.

BIRMINGHAM	W. Cramp, D.Sc., M.I.E.E.
BRISTOL	D. Robertson, D.Sc., M.I.E.E.
DURHAM, Armstrong College, Newcastle-on-Tyne	W. M. Thornton, O.B.E., D.Sc., D.Eng., M.I.E.E.
LEEDS	E. L. E. Wheatcroft, M.A.
LIVERPOOL	E. W. Marchant, D.Sc.

LONDON.	
University College ..	W. C. Clinton, B.Sc., M.I.E.E.
King's College	Ernest Wilson, M.I.C.E., M.I.E.E.
Imperial College of Science and Technology.	C. L. Fortescue, O.B.E., M.A., M.I.C.E., M.I.E.E.
East London College ..	J. T. MacGregor-Morris, M.I.M.E.
MANCHESTER, College of Technology.	Robert Beattie, D.Sc. Miles Walker, M.A., D.Sc.
UNIVERSITY COLLEGE OF SOUTHAMPTON.	H. Stansfield, D.Sc.
EDINBURGH, Heriot Watt College.	Francis G. Bailey, M.A., M.I.C.E., F.R.S.E.
GLASGOW, Royal Technical College.	G. W. O. Howe, D.Sc. S. Parker Smith, D.Sc., M.I.E.E., A.M.I.C.E.
BELFAST, Queen's University	P. L. Burns, B.Sc., A.M.I.E.E.

Mechanical Engineering.

BIRMINGHAM	F. W. Burstall, M.Sc., M.A., M.I.Mech.E.
BRISTOL	A. Robertson, D.Sc.
DURHAM, Armstrong College, Newcastle-on-Tyne.	C. J. Hawkes, M.Sc., A.M.I.C.E., M.I.N.A., M.I.Mech.E.
LEEDS	W. T. David, M.A., Sc.D., M.I.C.E., M.I.Mech.E.
LIVERPOOL	G. E. Scholes, M.B.E., M.Sc., M.I.Mech.E., M.I.A.E.
LONDON.	
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King's College	Gilbert Cook, D.Sc., A.M.I.C.E., M.I.Mech.E.
Imperial College of Science and Technology.	W. E. Dalby, M.A., B.Sc., M.I.C.E., M.I.M.E., F.R.S.
East London College ..	E. H. Lamb, D.S.C., M.Sc., M.I.M.E., A.M.I.C.E.
MANCHESTER, College of Technology	Dempster Smith, M.B.E., M.Sc.Tech., M.I.Mech.E.
SHEFFIELD	F. C. Lea, O.B.E., D.Sc., M.I.C.E., M.I.M.E., A.R.C.S.
UNIVERSITY COLLEGE OF SOUTHAMPTON.	J. Eustice, B.Sc., A.R.S.M., A.M.I.C.E.
EDINBURGH, Heriot Watt College.	Richard Stanfield, M.I.C.E., M.I.Mech.E., A.R.S.M., F.R.S.E.
GLASGOW, Royal Technical College.	J. D. Cormack, C.M.G., C.B.E., D.Sc. A. L. Mellanby, D.Sc., M.I.Mech.E.
ST. ANDREW'S	A. R. Fulton, D.Sc.
BELFAST, Queen's University	J. M. Smith, D.Sc., A.R.C.Sc.

GEOLOGY.

BIRMINGHAM	W. S. Boulton, D.Sc., A.R.C.S., M.I.Min.E., F.G.S.
BRISTOL	S. H. Reynolds, M.A., Sc.D.
CAMBRIDGE	J. E. Marr, Sc.D.

DURHAM, Armstrong College, Newcastle-on-Tyne.	A. Holmes, D.Sc., F.G.S. H. G. A. Hickling, D.Sc., F.G.S., M.I.Min.E.
LEEDS	A. Gilligan, D.Sc., F.G.S.
LIVERPOOL	P. G. H. Boswell, O.B.E., D.Sc., M.I.M.M., F.G.S.
LONDON.	
University College ..	E. J. Garwood, Sc.D., M.A., F.R.S.
King's College	W. T. Gordon, M.A., D.Sc.
Imperial College of Science and Technology.	W. W. Watts, M.A., Sc.D., LL.D., F.R.S. C. G. Cullis, D.Sc., M.I.M.M. (*Economic Mineralogy*).
MANCHESTER	O. T. Jones, M.A., D.Sc., F.R.S.
OXFORD	W. J. Sollas, M.A.
READING	H. L. Hawkins, D.Sc., F.G.S.
SHEFFIELD	W. G. Fearnsides, M.A.
UNIVERSITY COLLEGE OF THE SOUTH-WEST OF ENGLAND, EXETER.	W. S. Lewis, M.Sc., F.R.G.S.
UNIVERSITY COLLEGE OF NOTTINGHAM.	H. H. Swinnerton, D.Sc.
UNIVERSITY COLLEGE OF SOUTHAMPTON.	W. R. Sherriffs, M.A., D.Sc.
WALES.	
University College of Wales, Aberystwyth.	W. J. Pugh, O.B.E., D.Sc., B.A., F.G.S.
University College of South Wales, Cardiff.	A. H. Cox, D.Sc., Ph.D., F.G.S.
ABERDEEN	A. W. Gibb, M.A., D.Sc.
EDINBURGH	T. J. Jehu, M.A., M.D.
GLASGOW	J. W. Gregory, D.Sc., Ph.D., F.R.S.
BELFAST, Queen's University	J. K. Charlesworth, D.Sc., Ph.D.

ECONOMICS.

CAMBRIDGE	A. C. Pigou, M.A.
DURHAM, Armstrong College, Newcastle-on-Tyne.	H. M. Hallsworth, O.B.E., M.A., M.Com.
LEEDS	J. H. Jones, M.A.
LONDON, London School of Economics.	Allyn A. Young, Ph.D. (*Political Economy*). H. J. Laski, M.A. (*Political Science*).
MANCHESTER	G. W. Daniels, M.A., M.Com. H. Clay, M.A., M.Com.
OXFORD	D. H. Macgregor, M.A.
SHEFFIELD	D. Knoop, M.A.
UNIVERSITY COLLEGE OF NOTTINGHAM	A. W. Kirkaldy, M.A., B.Litt., M.Com.
WALES.	
University College of Wales, Aberystwyth.	E. A. Lewis, D.Sc., M.A., D.Litt.
University College of South Wales, Cardiff.	W. J. Roberts, M.A.
ABERDEEN	Alex. Gray, M.A.
EDINBURGH	F. W. Ogilvie, M.A.

GLASGOW	W. R. Scott, Litt.D., D.Phil.
BELFAST, Queen's University	H. O. Meredith, O.B.E., M.A., M.Com.

ACCOUNTANCY.

BIRMINGHAM	C. E. Martineau, M.A., M.Com., F.C.A.
LONDON, London School of Economics.	F. R. M. de Paula, O.B.E., F.C.A.
ABERDEEN	John Reid, C.A.
EDINBURGH	W. Annan, C.A.
GLASGOW	J. Loudon, M.A., C.A.

GEOGRAPHY.

LIVERPOOL	P. M. Roxby, B.A.
LONDON.	
University College ..	C. B. Fawcett, D.Sc., B.Litt. (*Economic*).
King's College	The Professors of Botany, Geology, Civil Engineering, Imperial History, Physics (in conjunction with the staff of the London School of Economics).
Birkbeck College ..	J. F. Unstead, M.A., D.Sc.
London School of Economics	L. Rodwell Jones, B.Sc., Ph.D.
UNIVERSITY COLLEGE OF THE SOUTH-WEST OF ENGLAND, EXETER.	W. S. Lewis, M.Sc., F.R.G.S.
UNIVERSITY COLLEGE OF NOTTINGHAM.	H. H. Swinnerton, D.Sc.
UNIVERSITY COLLEGE OF SOUTHAMPTON.	O. H. T. Rishbeth, M.A., F.R.G.S.
WALES, University College of Wales, Aberystwyth.	H. J. Fleure, D.Sc.
ABERDEEN	John McFarlane, M.A., M.Com.

STATISTICS.

DURHAM, Armstrong College	H. M. Hallsworth, O.B.E., M.A., M.Com.
LONDON.	
University College ..	Karl Pearson, M.A., LL.D., F.R.S. (*Eugenics*).
London School of Economics	A. L. Bowley, Sc.D., F.B.A.

INDUSTRIAL ASSOCIATIONS.

The British Research Association for the Woollen and Worsted Industries. "Torridon," Headingley, Leeds.
Director: S. G. Barker, Ph.D.

The British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester.
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The British Leather Manufacturers' Research Association, 26, St. Thomas' Street, London, S.E.1.
Director: Miss D. Jordan Lloyd, D.Sc.

The British Silk Research Association, 19, Russell Square, London, W.C.1.
Director: W. S. Denham, D.Sc., F.I.C.

The Research Association of British Flour Millers, 40, Trinity Square, London, E.C.3.
Director: E. A. Fisher, M.A., B.Sc., F.I.C.

Research Association of British Paint, Colour and Varnish Manufacturers, 8, St. Martins Place, Trafalgar Square, London, W.C.2.
Director: L. A. Jordan, D.Sc., F.I.C.

The Linen Industry Research Association, Lambeg, Belfast.
Director: W. H. Gibson, O.B.E., D.Sc., F.I.C., F.Inst.P.

III.

PROFESSORS, READERS AND LECTURERS IN AGRICULTURAL SCIENCE AND COGNATE PURE SCIENCES AT UNIVERSITIES AT WHICH RESEARCH AND TEACHING IN AGRICULTURE IS CARRIED OUT.

(NOTE :—The names of individual lecturers are given for agricultural subjects only : in the case of cognate sciences the number of lecturers alone is given.)

UNIVERSITIES.

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UNIVERSITY OF BRISTOL.

Registrar : E. G. Francis, M.A.

The following agricultural research institutes are connected with the University :—Horticultural Research Institute, Long Ashton (*see* p. 51), and the Fruit and Vegetable Preservation Station, Campden, Glos. (*see* p. 56).

AGRICULTURE.—*Professors:* B. T. P. Barker, M.A. (*Agricultural Biology*); J. A. Hanley, A.R.C.S., Ph.D. *Lecturers:* T. Wallace, M.Sc., A.I.C. (*Agricultural Chemistry*); O. Grove, M.Sc. (*Oenology*); C. L. Walton, M.Sc., Ph.D. (*Entomology*); G. T. Spinks, M.A. (*Agricultural Botany*); F. Tutin, M.Sc. (*Bio-Chemistry*); J. G. Maynard, M.A. (*Pomology*); H. P. Hutchinson, B.Sc. (*Willow-growing*); F. Hirst, A.R.C.S. (*Micro-Biology*).

ANATOMY.—*Professor:* E. Fawcett, M.D., C.M., F.R.S. One lecturer.

BIO-CHEMISTRY. One lecturer.

BOTANY.—*Professor:* O. V. Darbishire, B.A., Ph.D., F.L.S. Three lecturers. One special lecturer in systematic botany.

CHEMISTRY.—*Professors:* F. Francis, D.Sc., Ph.D., F.I.C.; W. E. Garner, M.A., D.Sc. (*Physical*). *Fellow in Applied Physical Chemistry and Hon. Prof.:* M. W. Travers, D.Sc., F.R.S. Five lecturers (one in hygienic chemistry).

ECONOMICS. Two lecturers.

ENGINEERING.—*Professors:* A. J. S. Pippard, M.B.E., D.Sc. (*Civil*); D. Robertson, D.Sc., M.I.E.E. (*Electrical*); A. Robertson, D.Sc. (*Mechanical*). One lecturer in each of civil, electrical and mechanical engineering.

GEOGRAPHY.—*Reader:* W. W. Jervis, M.Sc., F.G.S. Two lecturers.

GEOLOGY.—*Professor:* S. H. Reynolds, M.A., Sc.D. Three lecturers.

PATHOLOGY AND BACTERIOLOGY.—One lecturer.

PHYSICS.—*Professors:* A. M. Tyndall, D.Sc.; J. E. Lennard-Jones, D.Sc., Ph.D. *Research Fellows:* H. W. Skinner, M.A., Ph.D.; L. C. Jackson, M.Sc., Ph.D. Four lecturers.

PHYSIOLOGY.—*Professor:* G. A. Buckmaster, M.A., M.D., B.Ch., D.P.H. Two lecturers.

ZOOLOGY.—*Reader:* W. D. Henderson, M.A., B.Sc., Ph.D. One Lecturer.

UNIVERSITY OF CAMBRIDGE.

Registrary: E. Harrison, M.A.

The following agricultural research institutes are connected with or situate near the University:—Plant Breeding Institute (*see* p. 29), Horticultural Research Station (*see* p. 61), Animal Nutrition Institute (*see* p. 77), Small Animal Breeding Institute (*see* p. 91), Department of Animal Pathology (*see* p. 68), National Institute of Agricultural Botany (*see* p. 37) and the Low Temperature Research Station (*see* p. 100).

AGRICULTURE.—*Professor :* T. B. Wood, C.B.E., M.A., F.R.S., F.I.C. *Lecturers:* J. A. Venn, M.A. (*Agricultural Economics*); A. Amos, M.A.; W. S. Mansfield, M.A. (*Animal Husbandry*); E. McKenzie Taylor, Ph.D. (*Agricultural Chemistry*); G. Udny Yule, C.B.E., M.A., F.R.S. (*Statistical Method*); J. Line, M.A (*Botany*); E. P. Weller, M.A. (*Estate Management*);

AGRICULTURAL BOTANY.—*Professor:* Sir Rowland H. Biffen, M.A., F.R.S. *Lecturer:* F. L. Engledow, M.A. (*Genetics*).

AGRICULTURAL PHYSIOLOGY.—*Reader:* F. H. A. Marshall, Sc.D., F.R.S.

ANATOMY.—*Professor:* J. T. Wilson, M.A. *Reader:* W. L. H. Duckworth, M.D., Sc.D. Two lecturers (one in *Embryology*).

ANIMAL PATHOLOGY.—*Professor:* J. B. Buxton, M.A.

ASTROPHYSICS.—*Professor:* F. J. M. Stratton, M.A., D.S.O. One lecturer.

BIO-CHEMISTRY.—*Professor:* Sir F. G. Hopkins, M.A., F.R.S. *Reader:* J. B. S. Haldane, M.A. Two lecturers.

BIOLOGY.—*Professor:* G. H. F. Nuttall, Sc.D., F.R.S. (Director of Molteno Institute of Parasitology). One lecturer in parasitology.

BOTANY.—*Professor:* A. C. Seward, Sc.D., F.R.S., F.L.S. *Reader* F. F. Blackman, M.A., F.R.S. Three lecturers (one in Plant Physiology).

CHEMISTRY.—*Professors:* Sir Wm. J. Pope, K.B.E., M.A., F.R.S. T. M. Lowry, C.B.E., M.A., F.R.S. (*Physical*); F. G. Mann. Ph.D. (Assistant to Sir W. J. Pope). Five lecturers (one in Organic, one in Physical).

ECONOMICS AND POLITICAL ECONOMY.—*Professor:* A. C. Pigou, M.A. Eleven lecturers.

ENGINEERING.—*Professor:* C. E. Inglis, M.A. (*Mechanism and Applied Mechanics*). *Reader:* C. G. Lamb, Sc.D. (*Electrical*). Eighteen lecturers (one in Mechanical).

GENETICS.—*Professor:* R. C. Punnett, M.A., F.R.S. (*Plant Genetics and Small Animal Breeding*).

GEOGRAPHY.—*Reader:* F. Debenham, M.A.; Three lecturers (one in Economic).

GEOLOGY.—*Professor:* J. E. Marr, Sc.D., F.R.S. Three lecturers (one in Economic).

NATURAL PHILOSOPHY.—*Professor:* C. T. R. Wilson, M.A.

PATHOLOGY.—*Professor:* H. R. Dean, M.D. Three lecturers.

PHYSICS.—*Professors:* Sir Ernest Rutherford, O.M., M.A., Hon. Sc.D., F.R.S. (*Experimental*), Sir J. J. Thomson, O.M., M.A., Hon. Sc.D., F.R.S. Five lecturers (one in Experimental).

PHYSIOLOGY.—*Professor:* J. Barcroft, C.B.E., M.A., F.R.S. Four lecturers.

STATISTICS. One lecturer.

ZOOLOGY.—*Professor:* J. S. Gardiner, M.A., F.R.S., F.L.S. Four lecturers (one in Entomology).

UNIVERSITY OF DURHAM.

Registrar: H. G. Theodosius, M.A., 38, North Bailey, Durham.

Durham Colleges.

BOTANY.—*Reader:* B. M. Griffiths, D.Sc., F.L.S. One lecturer.

CHEMISTRY.—*Professor:* J. I. Orme Masson, D.Sc., F.I.C. Three lecturers.

ECONOMICS.—One lecturer.

GEOLOGY.—*Professor:* A. Holmes, D.Sc., F.G.S. One lecturer.

PHYSICS.—*Professor:* J. E. P. Wagstaff, M.A., D.Sc. Two lecturers.

College of Medicine, Newcastle-on-Tyne.

ANATOMY.—*Professor:* R. B. Green, M.A., M.B., B.S., F.R.C.S.

BIOLOGY.—*Professors:* J. W. H. Harrison, D.Sc., F.R.S. (*Botany*); A. Meek, D.Sc., F.Z.S. (*Zoology*).

CHEMISTRY.—*Professors*: H. V. A. Briscoe, D.Sc., A.R.C.Sc., D.I.C. (*Inorganic*); G. R. Clemo, D.Sc., Ph.D., F.I.C. (*Organic*).

PATHOLOGY.—*Professor:* S. McDonald, M.D., M.A.. One lecturer.

BACTERIOLOGY AND COMPARATIVE PATHOLOGY.—*Professor*: H. J. Hutchens, D.S.O., M.A., D.P.H.

PHYSICS.—*Professors :* W. E. Curtis, D.Sc., A.R.C.S.; G. W. Todd, M.A., D.Sc.

PHYSIOLOGY.—*Professor:* David Burns, M.A., D.Sc. One lecturer.

Armstrong College, Newcastle-on-Tyne.

Registrar: J. Y. T. Greig, M.A., D.Litt.

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AGRICULTURAL CHEMISTRY.—*Lecturer:* A. A. Hall, M.Sc., Ph.D., F.I.C.

AGRICULTURAL ZOOLOGY.—*Lecturer:* L. Morrison, B.Sc.

BOTANY.—*Professor and Reader in Genetics:* J. W. H. Harrison, D.Sc., F.R.S. Three lecturers.

CHEMISTRY.—*Professors:* H. V. A. Briscoe, D.Sc., A.R.C.Sc., D.I.C. (*Inorganic and Physical*); G. R. Clemo, D.Sc., Ph.D., D.Phil., F.I.C. (*Organic*). Seven lecturers.

ECONOMICS.—*Professor:* H. M. Hallsworth, O.B.E., M.A., M.Com. Three lecturers.

ENGINEERING.—*Professors:* C. J. Hawkes, M.Sc., A.M.I.C.E., M.I.N.A., M.I.Mech.E.; W. M. Thornton, O.B.E., D.Sc., D.Eng., M.I.E.E. *Reader:* J. Morrow, M.Sc., D.Eng. Eight lecturers (six in Civil and Mechanical and two in Electrical).

GEOGRAPHY.—One lecturer.

GEOLOGY.—*Professor:* H. G. A. Hickling, D.Sc., F.G.S., M.I. Min.E. Three lecturers.

PHYSICS.—*Professors:* W. E. Curtis, D.Sc., A.R.C.Sc., D.I.C., F.R.A.S.; G. W. Todd, M.A., D.Sc., F.Inst.P., F.P.S.L. Four lecturers.

ZOOLOGY.—*Professor:* A. Meek, D.Sc., F.Z.S. Two lecturers.

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AGRICULTURAL BOTANY.—*Lecturer:* W. A. Millard, D.Sc.

AGRICULTURAL CHEMISTRY.—*Professors:* N. M. Comber, D.Sc., A.R.C.S., F.I.C. *Lecturer:* One (vacant).

AGRICULTURAL ZOOLOGY.—*Lecturer:* T. H. Taylor, M.A.

BIO-CHEMISTRY.—One lecturer.

BOTANY.—*Professor:* J. H. Priestley, D.S.O., B.Sc., F.L.S. *Reader:* W. H. Pearsall, D.Sc. Two lecturers (one in Morphology) and one honorary lecturer in Mycology.

CHEMISTRY.—*Professors:* R. W. Whytlaw-Gray, O.B.E., Ph.D., F.I.C.; C. K. Ingold, D.Sc., A.R.C.S., D.I.C., F.I.C., F.R.S. (*Organic*); H. M. Dawson, D.Sc., Ph.D. (*Physical*). *Reader:* F. L. Usher, D.Sc. (*Colloid Chemistry*). Five lecturers (two in Organic and one in Analytical).

ECONOMICS.—*Professor:* J. H. Jones, M.A. Four lecturers (one in Accountancy).

ENGINEERING.—*Professors:* W. T. David, M.A., Sc.D., M.I.C.E., M.I.Mech.E. (*Civil and Mechanical*); E. L. E. Wheatcroft, M.A. (*Electrical*). Three lecturers (two in Civil and Mechanical and one in Electrical).

GEOGRAPHY.—*Reader:* (Vacant). *Lecturer and Acting Head:* A. V. Williamson, M.A.

GEOLOGY.—*Professor:* A. Gilligan, D.Sc., F.G.S. One lecturer.

PATHOLOGY AND BACTERIOLOGY.—*Professors:* M. J. Stewart, M.B., Ch.B., F.R.C.P.; J. W. McLeod, O.B.E., M.B., Ch.B. (*Bacteriology*); R. D. Passey, M.C., M.D., B.S., D.P.H. Six lecturers (one in Chemical Pathology, one in Experimental Pathology and one in Bio-Chemistry).

PHYSICS.—*Professor:* R. Whiddington, M.A., D.Sc., F.R.S. *Reader:* E. C. Stoner, B.A., Ph.D. One lecturer.

PHYSIOLOGY.—*Professor:* B. A. McSwiney, B.A., Sc.D., M.B., Ch.B. Three lecturers.

VETERINARY HYGIENE.—One lecturer.

ZOOLOGY.—*Professor:* W. Garstang, M.A., D.Sc., F.L.S. One lecturer.

LEATHER INDUSTRIES.—*Professor:* D. McCandlish, M.Sc. Two lecturers.

TEXTILE INDUSTRIES.—*Professor:* A. F. Barker, M.Sc. Five lecturers.

UNIVERSITY OF LONDON.

Academic Registrar: Edwin Deller, LL.D.

The following agricultural research institutes are connected with or situate near the University:—Royal Botanic Gardens, Kew (*see* p. 25), Research Institute in Plant Physiology, Imperial College of Science (*see* p. 26), Research Institute in Animal Pathology, Royal Veterinary College (*see* p. 65), the Institute of Agricultural Parasitology, London School of Hygiene and Tropical Medicine (*see* p. 75), the John Innes Horticultural Institution (*see* p. 64), Rothamsted Experimental Station, Harpenden, Herts. (*see* p. 10), the Experimental and Research Station, Cheshunt, Herts. (*see* p. 62), the Plant Pathological Laboratory of the Ministry of Agriculture (*see* p. 50), the Veterinary Research Laboratory of the Ministry of Agriculture (*see* p. 70), and the Foot and Mouth Disease Research Station at Pirbright, Surrey (*see* p. 72).

University College.

ANATOMY.—*Professors:* G. Elliot Smith, M.A., Litt.D., M.D., Ch.M., D.Sc., F.R.S.; J. P. Hill, D.Sc., F.R.S. (*Embryology*). One assistant professor; one lecturer and three honorary lecturers.

BOTANY.—*Professor:* F. W. Oliver, M.A., D.Sc., LL.D., F.R.S., F.L.S. *Readers:* T. G. Hill, D.Sc., A.R.C.S. (*Plant Physiology*); P. Haas, D.Sc., Ph.D. (*Plant Chemistry*); E. J. Salisbury, D.Sc. (*Plant Ecology*).

CHEMISTRY.—*Professors:* R. Robinson, D.Sc., F.R.S. (*Organic*); F. G. Donnan, C.B.E., M.A., D.Sc., Ph.D., F.R.S., F.I.C. (*General*). *Reader:* O. L. Brady, B.A., D.Sc., F.I.C. (*Organic*). Two lecturers (one Inorganic Analytical).

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PHYSICS.—*Professor:* E. N. da C. Andrade, D.Sc., Ph.D. Four lecturers.

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STATISTICS, APPLIED.—*Professor:* Karl Pearson, M.A., LL.D., F.R.S. (*Eugenics*). *Reader:* P. Stocks, M.A., M.D., B.Ch., D.P.H. (*Medical*).

ZOOLOGY.—*Professor:* D. M. S. Watson, M.Sc., F.R.S. Two lecturers.

King's College.

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ENGINEERING.—*Professors:* A. H. Jameson, M.Sc., M.I.C.E. (*Civil*); Ernest Wilson, M.I.C.E., M.I.E.E. (*Electrical*); Gilbert Cook, D.Sc., A.M.I.C.E., M.I.Mech.E. (*Mechanical*). *Readers:* S. J. Davies, M.Sc., M.I.Mech.E. (*Mechanical*); C. H. Lobban, D.Sc., A.M.I.C.E. (*Civil*). Three lecturers (one in Civil and two in Electrical).

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PHYSIOLOGY.—*Professor:* R. J. S. McDowall, D.Sc., M.B., Ch.B. Two lecturers.

ZOOLOGY.—*Professor:* Doris L. MacKinnon, D.Sc., F.L.S. Two lecturers and one honorary lecturer.

Imperial College of Science and Technology.

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GEOLOGY.—*Reader:* H. G. Smith, B.Sc., A.R.C.S.

PHYSICS.—*Professor:* C. H. Lees, D.Sc., F.R.S. Four lecturers.

ZOOLOGY.—*Head of Department:* G. P. Mudge, A.R.C.S., F.Z.S. One lecturer.

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Lister Institute of Preventive Medicine.

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CHEMISTRY.—H. C. Candy, B.A., B.Sc., F.I.C.

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Middlesex Hospital Medical School.

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University College Hospital Medical School.

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Westminster Hospital Medical School.

BACTERIOLOGY.—*Reader:* J. A. B. Hicks, M.D., M.S.

National Institute for Medical Research.

BACTERIOLOGY AND EXPERIMENTAL PATHOLOGY.—S. R. Douglas, F.R.S.

PHYSIOLOGY.—H. H. Dale, C.B.E., M.A., M.D., F.R.S.; L. E. Hill, M.B., F.R.C.S.

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CHEMISTRY.—*Professor:* G. W. Clough, D.Sc.

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MATERIA MEDICA.—*Professor:* A. R. Smythe, M.R.C.V.S., D.V.S.M.

PATHOLOGY AND BACTERIOLOGY.—*Professor:* Tom Hare, M.D., Ch.B., B.V.Sc., M.R.C.V.S.

PHYSIOLOGY AND HISTOLOGY.—*Professor:* W. Legge Symes, M.R.C.S.

SURGERY.—*Professor:* J. MacQueen, F.R.C.V.S.

UNIVERSITY OF OXFORD.

Registrar: E. S. Craig, M.A.

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AGRICULTURAL CHEMISTRY.—*Reader:* C. G. T. Morison, M.A.

AGRICULTURAL HISTORY.—*Lecturer:* R. V. Lennard, M.A.

AGRICULTURAL LAW.—*Lecturer:* G. C. Cheshire, D.C.L.

ECONOMICS AND HISTORY.—*Lecturer:* G. D. Amery, M.A.

ESTATE MANAGEMENT.—*Lecturer:* D. T. Thring, Hon. M.A.

ANATOMY.—*Professor:* A. Thomson, M.A. *Reader:* A. P. Dodds-Parker, B.M., M.A.

BIO-CHEMISTRY.—*Professor:* R. A. Peters, M.A.

BOTANY.—*Professor:* A. G. Tansley, M.A., F.R.S., F.L.S.

CHEMISTRY.—*Professors:* W. H. Perkin, M.A., F.R.S.; F. Soddy, M.A., F.R.S. *Reader:* N. V. Sidgwick, M.A. Three lecturers.

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PHYSICS.—*Professor:* J. S. E. Townsend, M.A.

PHYSIOLOGY.—*Professor:*—Sir Charles S. Sherrington, O.M., G.B.E., M.A., Hon. D.Sc., F.R.S. *Reader:* J. G. Priestley, D.M. (*Clinical*).

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UNIVERSITY OF READING.

Registrar: H. Knapman, M.A.

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AGRICULTURAL BACTERIOLOGY.—*Lecturer:* Grace H. Mason, N.D.D.

AGRICULTURAL BOTANY.—*Professor:* J. Percival, M.A., Sc.D., F.L.S. *Lecturers:* Adela G. Erith, B.Sc., Ph.D.; J. S. L. Waldie, B.Sc.

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DAIRYING.—*Lecturer:* A. Todd.

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DAIRY HUSBANDRY.—*Lecturer:* J. Mackintosh, O.B.E., N.D.A., N.D.D.

HORTICULTURE.—*Lecturer:*—A. J. Cobb.

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ZOOLOGY.—*Professor:* F. J. Cole, D.Sc., F.R.S. One lecturer.

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Registrar: D. Brynmor Anthony, M.C., M.A., University Registry, Cathays Park, Cardiff.

The following agricultural research institute is connected with the University:—Welsh Plant Breeding Station, Aberystwyth (*see* p. 31).

University College of Wales, Aberystwyth.

AGRICULTURE.—*Professor:* J. J. Griffith, B.Sc. *Lecturer:* R. Phillips, M.Sc.

AGRICULTURAL BOTANY.—*Professor:* R. G. Stapledon, M.B.E., M.A. *Lecturer:* Kathleen Sampson, M.Sc.

AGRICULTURAL CHEMISTRY.—*Head of Department:* T. W. Fagan, M.A., F.I.C. *Lecturer:* R. O. Davies, M.Sc.

AGRICULTURAL ECONOMICS.—*Special Lecturer:* A. W. Ashby, M.A.

BOTANY.—*Professor:* Wilfrid Robinson, D.Sc., F.L.S. One lecturer.

CHEMISTRY.—*Professor:* T. C. James, M.A., D.Sc., F.I.C. Two lecturers.

ECONOMICS.—*Professor:* E. A. Lewis, M.A., D.Litt., D.Sc. One lecturer.

GEOGRAPHY.—*Professor:* H. J. Fleure, D.Sc. One lecturer.

GEOLOGY.—*Professor:* W. J. Pugh, O.B.E., B.A., D.Sc., F.G.S. One lecturer.

PHYSICS.—*Professors:* Gwilym Owen, M.A., D.Sc. and D. Morgan Lewis, M.A.

ZOOLOGY.—*Professor:* R. D. Laurie, M.A.

University College of North Wales, Bangor.

AGRICULTURE.—*Professor:* R. G. White, M.Sc. *Lecturer:* E. Jones Roberts, M.A., M.Sc. *Hon. Lecturer:* J. A. F. Roberts, B.A., B.Sc. (*Animal Breeding*).

AGRICULTURAL BOTANY.—*Head of Department:* R. Alun Roberts, Ph.D.

AGRICULTURAL CHEMISTRY.—*Professor:*—G. W. Robinson, M.A. *Lecturer:* W. McLean, B.A., B.Sc., A.R.C.Sc., A.I.C.

BOTANY.—*Professor:* D. Thoday, M.A. Two lecturers.

CHEMISTRY.—*Professor:* K. J. P. Orton, M.A., Ph.D., F.R.S., F.I.C. Two lecturers (one in physical).

ECONOMICS.—*Head of Department:* Henry Higgs, C.B., LL.B.

PHYSICS.—*Professor:* E. A. Owen, M.A., D.Sc., F.Inst.P. One lecturer.

ZOOLOGY.—*Professor:* P. J. White, M.B.

University College of South Wales and Monmouthshire, Cardiff.

ANATOMY.—*Professor:* C. McLaren West, M.C., M.B., B.A.O., B.Ch., Sc.D. Two lecturers.

BOTANY.—*Professor:* R. C. McLean, M.A., D.Sc., F.L.S.

CHEMISTRY.—*Professor:* W. J. Jones, D.Sc., F.I.C., F.Inst.P. *Assistant Professor:* E. P. Perman, D.Sc., F.I.C. One lecturer in organic.

ECONOMICS.—*Professor:* W. J. Roberts, M.A. One lecturer.

ENGINEERING.—*Professor:* W. Norman Thomas, M.A., D.Phil., M.Sc. Two lecturers.

GEOLOGY.—*Professor:* A. H. Cox, D.Sc., Ph.D., F.G.S. Two lecturers.

PHYSICS.—*Professor:* H. R. Robinson, D.Sc., Ph.D., F.R.S.E. Four lecturers.

PHYSIOLOGY.—*Professor:* T. Graham Brown, M.D., D.Sc., F.R.S. Three lecturers.

ZOOLOGY.—*Professor:* W. M. Tattersall, D.Sc. Two lecturers.

PATHOLOGY AND BACTERIOLOGY.—*Professor:* J. H. Dible, M.B., Ch.B. Two lecturers.

University College of Swansea.

BIOLOGY.—*Head of Department:* Miss F. A. Mockeridge, D.Sc.

CHEMISTRY.—*Professor:* J. E. Coates, O.B.E., D.Sc., F.I.C. One lecturer in Organic.

ENGINEERING.—*Professor:* F. Bacon, M.A., A.M.I.C.E., M.I.M.E., M.I.E.E. Two lecturers (one in Civil and one in Electrical).

GEOLOGY.—*Head of Department:* A. E. Trueman, D.Sc.

PHYSICS.—*Professor:* E. J. Evans, D.Sc., A.R.C.S. One lecturer.

UNIVERSITY OF ABERDEEN.

Secretary: H. J. Butchart, D.S.O., B.L.

The following agricultural research institutes are connected with the University:—Soils and Drainage Department (*see* p. 20) and the Rowett Research Institute (*see* p. 80).

AGRICULTURE.—*Professor:* J. Hendrick, B.Sc. *Lecturer:* W. J. Profeit, M.A., B.Sc. (*Agric.*).

AGRICULTURAL BOTANY.—*Lecturer:* R. M. Clark, B.Sc., F.L.S.

AGRICULTURAL ZOOLOGY.—*Lecturer:*

AGRICULTURAL ENGINEERING.—*Lecturer:* John A. Chisholm, Assoc. H.W.C., A.M.I.C.E.

SURVEYING.—*Lecturer:* F. R. Stewart, B.Sc.(Eng.), A.M.I.C.E.

ACCOUNTANCY.—One lecturer; an assistant in agricultural book-keeping.

ANATOMY.—*Professor:* Alexr. Low, M.A., M.D. Two lecturers (one in Embryology).

BACTERIOLOGY.—*Professor:* J. Cruickshank, M.D., D.Sc.

BIO-CHEMISTRY.—One lecturer.

BOTANY.—*Professor:* W. G. Craib, M.A., F.R.S.E., F.L.S. One lecturer.

CHEMISTRY.—*Professor:* Alexr. Findlay, M.A., D.Sc., Ph.D. Three lecturers.

ENGINEERING.—*Professor:* W. Blackadder, D.Sc., A.M.I.C.E. Two lecturers (one in Electrical and one in Mechanical).

FOREST BOTANY AND FOREST ZOOLOGY.—One lecturer.

GEOGRAPHY.—*Reader:* J. McFarlane, M.A., M.Com.

GEOLOGY.—*Professor:* A. W. Gibb, M.A., D.Sc.

METEOROLOGY.—One lecturer.

NATURAL PHILOSOPHY.—*Professor:* G. P. Thomson, M.A. Two lecturers.

PATHOLOGY.—*Professor:* T. Shennan, M.D.

PHYSIOLOGY.—*Professor:* J. R. R. MacLeod, D.Sc., LL.D., M.B., Ch.B., F.R.S. One lecturer (Experimental) and one research lecturer (Physiology of Nutrition).

POLITICAL ECONOMY.—*Professor:* A. Gray, M.A. Two lecturers (Economic History and Public Finance).

STATISTICAL METHODS. One lecturer.

UNIVERSITY OF EDINBURGH.

Secretary: W. A. Fleming, M.A., LL.B.

The following agricultural research institutes are connected with or situate near the University:—Animal Breeding Research Department (*see* p. 92), Scottish Society for Research in Plant Breeding (*see* p. 34), Seed Testing and Plant Registration Station (*see* p. 41), and the Scottish Animal Diseases Research Association (*see* p. 72).

AGRICULTURE.—*Professor:* E. Shearer, M.A., B.Sc. *Lecturers:* J. A. More, B.Sc.; J. Evans Gordon, B.Sc.; A. Lauder (*Agricultural Chemistry*); John Cowan, K.C. (*Agricultural Law*).

ACCOUNTANCY.—*Professor:* W. Annan, C.A.

ANATOMY.—*Professor:* A. Robinson, M.D. Three lecturers.

ANIMAL GENETICS.—*Professor:* F. A. E. Crew, M.D., D.Sc., Ph.D. Three lecturers.

BOTANY.—*Professor:* Wm. Wright Smith, M.A., F.R.S.E. *Reader:* M. Wilson, D.Sc. (*Mycology and Bacteriology*). Three lecturers (one in Plant Physiology).

CHEMISTRY.—*Professor:* J. P. Kendall, M.A., D.Sc. *Reader:* J. E. Mackenzie, D.Sc., Ph.D. Seven lecturers (one in Technical).

ECONOMICS AND POLITICAL ECONOMY.—*Professor:* F. W. Ogilvie, M.A. Five lecturers (one of Economic History and one in Statistics).

ENGINEERING.—*Professor:* Sir Thos. Hudson Beare, B.A., B.Sc., M.I.C.E. Four lecturers.

ENTOMOLOGY.—*Reader:* R. S. MacDougall, M.A., D.Sc.

GEOGRAPHY.—*Reader:* Alan G. Ogilvie, M.A., B.Sc. Two lecturers.

GEOLOGY.—*Professor:* T. J. Jehu, M.A., M.D. *Reader:* R. Campbell, M.A., D.Sc. Two lecturers.

NATURAL HISTORY AND ZOOLOGY.—*Professor:* J. H. Ashworth, D.Sc., F.R.S. Seven lecturers (one in Cytology and Experimental Zoology).

NATURAL PHILOSOPHY.—*Professors:* C. G. Barkla, M.A., D.Sc., F.R.S.; C. G. Darwin, M.A., F.R.S. *Reader:* G. A. Carse, M.A., D.Sc. Four lecturers.

PATHOLOGY AND BACTERIOLOGY.—*Professors:* J. Lorrain Smith, M.A., M.D., LL.D., F.R.S.; T. J. Mackie, M.D. (*Bacteriology*). Four lecturers.

PHYSIOLOGY.—*Professor:* Sir E. A. Sharpey Schafer, LL.D., F.R.S. Four lecturers (one in Chemical and one in Histology).

Royal (Dick) Veterinary College.

ANATOMY AND HISTOLOGY.—O. Charnock Bradley, M.D., D.Sc., M.R.C.V.S.

MEDICINE AND MATERIA MEDICA.—J. Russell Greig, M.R.C.V.S.

SURGERY AND OBSTETRICS.—W. M. Mitchell, M.C., M.B., B.Sc., M.R.C.V.S.

RESEARCH PROFESSOR IN ANIMAL PATHOLOGY.—W. A. Pool, M.R.C.V.S.

PATHOLOGY, BACTERIOLOGY AND MEAT INSPECTION.—D. C. Matheson, F.R.C.V.S., D.V.S.M.

PHYSIOLOGY.—H. Dryerre, M.R.C.S., L.R.C.P., Ph.D.

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BIOLOGY (ZOOLOGY AND BOTANY).—R. Stewart MacDougall, M.A., D.Sc.

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UNIVERSITY OF GLASGOW.

Registrar: Robt. Brough.

The following agricultural research institute is situate near the University:—Hannah Dairy Research Institute, Ayr (*see* p. 90).

ACCOUNTANCY.—*Professor:* J. Loudon, M.A., C.A.

ANATOMY.—*Professor:* T. H. Bryce, M.A., M.D., F.R.S. Three lecturers (one in Embryology).

BOTANY.—*Professor:* J. Montagu F. Drummond, M.A., F.R.S., F.L.S. Three lecturers.

CHEMISTRY.—*Professor:* G. G. Henderson, D.Sc., LL.D., F.R.S.; T. S. Patterson, D.Sc., Ph.D. (*Organic*); Andrew Hunter, M.A., B.Sc., M.B. (*Physiological*). Eleven lecturers (one in Analytical, two in Organic and two in Physical).

ECONOMICS AND POLITICAL ECONOMY.—*Professor:* W. R. Scott, Litt.D., D.Phil. Two Lecturers (one in Economic History and one in Social Economics).

ENGINEERING.—*Professors:* J. D. Cormack, C.M.G., C.B.E., D.Sc. (*Civil and Mechanical*); W. J. Goudie, D.Sc.; G. W. O. Howe, D.Sc. (*Electrical*). Ten lecturers (five in Civil and Mechanical and three in Electrical).

GEOGRAPHY.—One Lecturer.

GEOLOGY.—*Professor:* J. W. Gregory, D.Sc., F.R.S. Six lecturers.

NATURAL PHILOSOPHY.—*Professor:* E. Taylor Jones, D.Sc. Three lecturers.

PHYSICS, APPLIED.—*Professor:* J. G. Gray, D.Sc. Three lecturers.

PHYSIOLOGY.—*Professor:* E. P. Cathcart, C.B.E., M.D., D.Sc., LL.D., F.R.S. Three lecturers (one in Histology).

ZOOLOGY.—*Professor:* J. Graham Kerr, M.A., F.R.S., F.L.S., F.Z.S. Three lecturers.

BACTERIOLOGY.—*Professor:* C. H. Browning, M.D., D.P.H. One lecturer.

PATHOLOGY.—*Professors:* R. Muir, M.A., M.D., Sc.D., F.R.S.; J. H. Teacher, M.A., M.D. Four lecturers (two in Pathological Bio-Chemistry).

Royal Technical College.

BOTANY AND BACTERIOLOGY.—*Professor:* D. Ellis, D.Sc., Ph.D.

CHEMISTRY.—*Professors:* T. Gray, D.Sc., LL.D., Ph.D., F.I.C. (*Technical*); R. M. Caven, D.Sc., F.I.C. (*Inorganic and Analytical*); F. J. Wilson, D.Sc., Ph.D., F.I.C. (*Organic*). Eight lecturers (one in Technical, four in Inorganic and Analytical, one in Metallurgical and two in Organic).

ENGINEERING.—*Professors:* G. Moncur, B.Sc., M.I.C.E. (*Civil*); S. Parker Smith, D.Sc., M.I.E.E., A.M.I.C.E. (*Electrical*); A. L. Mellanby, D.Sc., M.I.Mech.E. (*Mechanical*). *Associate Professor:* Wm. Kerr, Ph.D., A.R.T.C. Nine lecturers (two in Civil, one in Electrical and six in Mechanical).

GEOLOGY.—One lecturer.

NATURAL PHILOSOPHY.—*Professor:* J. Muir, M.A., D.Sc. *Associate Professor:* D. B. M'Quistan, M.A., B.Sc. One lecturer.

TEXTILE MANUFACTURE.—One lecturer.

West of Scotland Agricultural College.

AGRICULTURE.—*Professor:* W. G. R. Paterson, B.Sc., N.D.A. (Hans.).

BOTANY.—*Professor:* W. Braid, B.A., B.Sc., F.L.S., F.R.S.E.

CHEMISTRY.—*Professor:* D. N. McArthur, Ph.D., D.Sc.

DAIRYING.—*Professor:* R. H. Leitch, M.A., B.Sc., N.D.A. (Hans.), N.D.D.

VETERINARY SCIENCE.—*Professor:* J. R. McCall, M.R.C.V.S.

ZOOLOGY.—*Professor:* L. A. L. King, M.A.

THE QUEEN'S UNIVERSITY OF BELFAST.

Registrar: Col. T. Sinclair, C.B., M.D., M.Ch., F.R.C.S.

The following agricultural research institutes are connected with or situate near the University:—Chemical and Animal Nutrition Division (*see* pp. 23 and 85), Seed Testing and Plant Disease Division (*see* p. 43), Plant Breeding Research Division (*see* p. 36), Animal Diseases Division (*see* p. 74), Crop and Animal Husbandry Division (*see* p. 86), Agricultural Research Institute (*see* p. 87) and Dairy Bacteriology Division (*see* p. 91).

AGRICULTURAL BOTANY AND PLANT DISEASES.—*Professor:* S. P. Mercer, B.Sc. *Lecturers:* D. Clouston, M.A., B.Sc.; A. E. Muskett, B.Sc., A.R.C.Sc.

AGRICULTURAL CHEMISTRY.—*Lecturers:* R. G. Baskett, B.Sc.; F. Dickinson, B.Sc.

AGRICULTURAL ECONOMICS.—*Lecturer:* D. A. E. Harkness, M.A.

AGRICULTURAL ZOOLOGY.—*Lecturer:* J. C. Rhynehart, F.R.C.Sc. (I),

AGRICULTURE: CROP AND ANIMAL HUSBANDRY.—*Lecturer:* Robert Rae, B.Agr.

PLANT GENETICS.—*Lecturer:* Ian W. Seaton, B.Sc.

DAIRY BACTERIOLOGY.—*Lecturer:* George Wilson, M.R.C.V.S., D.V.S.M,

ANIMAL HYGIENE.—*Lecturer:* J. P. Rice, B.Sc., M.R.C.V.S.

ACCOUNTANCY.—One lecturer.

ANATOMY. *Professor:* T. Walmsley, M.D. Two lecturers.

BIO-CHEMISTRY.—*Professor:* J. A. Milroy, M.A., M.D. One lecturer.

BOTANY.—*Professor:* J. Small, D.Sc., M.R.I.A., F.R.S.E., F.L.S. One lecturer.

CHEMISTRY.—*Professor:* A. W. Stewart, D.Sc. Two lecturers (one in Organic).

CHEMICAL TECHNOLOGY.—*Professor:* H. Wren, M.A., D.Sc., Ph.D. One lecturer.

ECONOMICS.—*Professor:* H. O. Meredith, O.B.E., M.A., M.Com.

ENGINEERING.—*Professors:* F. H. Hummel, M.Sc., A.M.I.C.E. (*Civil*); P. L. Burns, B.Sc., A.M.I.C.E. (*Electrical*); J. H. Smith, D.Sc., A.R.C.Sc. (*Mechanical*). Five lecturers (one in Civil, two in Electrical and two in Mechanical).

GEOLOGY.—*Professor:* J. K. Charlesworth, D.Sc., Ph.D.

PHYSICS.—*Professor:* W. B. Morton, M.A. Two lecturers.

PATHOLOGY.—*Professor:* W. St. C. Symmers, M.B. One lecturer (*Clinical*).

PHYSIOLOGY.—*Professor:* T. H. Milroy, M.D., B.Sc.

ZOOLOGY.—*Professor:* G. Wilson, O.B.E., M.A., D.Sc., Ph.D. One lecturer.

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